THE AMERICAN GAS-LIGHT JOURNAL AND CHEMICAL REPERTORY

Publishing Office, No. 42 Pine Street.

Devoted to the Interests of Illumination, Heating, Ventilation and Sanitary Improvement, Domestic Economy, and General Science. Including Water Supply and Distribution.

VOLUME XXIII. No. 12. Whole No. 396. | NEW YORK. THURSDAY DECEMBER 16, 1875. | $3 PER ANNUM IN ADVANCE.

Third Annual Meeting of the American Gas-Light Association.

HELD AT MASONIC TEMPLE, NEW YORK, OCTOBER 20TH, 1875

[Continued from page 224.]

ADDRESS OF PROF. C. F. CHANDLER.

PRODUCTS OF THE DISTILLATION OF COAL.

As in all cases of destructive distillation we have four classes of products:

1. The gases and vapors.
2. The water.
3. The tar.
4. The coke.

These products are very complex in composition, more than a hundred chemical compounds occur in them. These diagrams exhibit the names and chemical formulæ of the most important of them:

THE GAS.

1. *Luminants.*

	Formula.	Density.
1, Vapors of paraffines	C_nH_{2n+2}	
2, Propyl	$(C_3H_7)_2$	
3, Other alcohol radicals	C_nH_{2n+1}	
4, Olefiant gas, ethene	C_2H_4	·976
5, Propene	C_3H_6	1·490
6, Butene	C_4H_8	1·940
7, Vapors of other Olifines	C_nH_{2n}	
8, Acetylene	C_2H_2	·920
9, Vapors of other acetylenes	C_nH_{2n-2}	
10, Valelene?	C_nH_{2n-4}	
11, Benzole	C_6H_6	2·71
12, Vapors of toluol, xylol, etc.	C_nH_{2n-6}	
13, Phenylene, etc?	C_nH_{2n-8}	
14, Cinnamene, etc?	C_nH_{2n-10}	
15, Naphthalene	$C_{10}H_8$	
16, Diphenyl, etc?	$C_{12}H_{10}$	
17, Anthracene?	$C_{14}H_{10}$	
18, Pyrene	$C_{16}H_{10}$	
19, Crysene	$C_{18}H_{12}$	
20, Phenol, etc. (alcohols)	$C_nH_{2n-7}OH$	
21. Bases mentioned under tar		

2. *Diluents.*

1, Hydrogen	H	·0691
2, Marsh-gas, methane	CH_4	·5594
3, Carbonic oxide	CO	·9727

3. *Impurities.*

1, Sulphuretted hydrogen	H_2S	1·1747
2, Ammonium sulphydrate	NH_4HS	
3, Bisulphide of carbon	CS_2	
4, Oxysulphide of carbon?	CSO	
5, Sulphurous acid (anhydride)?	SO_2	
6, Mercaptan, etc.	C_2H_6HS	
7, Sulphur bases, etc.		
8, Ammonium sulphocyanide	NH_4CNS	
9, Ammonium cyanide	NH_4CN	
10, Ammonium mono-carbonate	NH_4HCO_3	
11, Carbonic acid (anhydride)	CO_2	1·5210
12, Nitrogen	N	.9760
13, Oxygen	O	1·1026
14, Aqueous vapor (water)	H_2O	·6201

II. THE AMMONIA-WATER.

1, Acid carbonate of ammonium	NH_4HCO_3
2, Hydrosulphate of ammonium	NH_4HS
3, Sulphocyanide of ammonium	NH_4CNS
4, Cyanide of ammonium	NH_4CN.
5, Chloride of ammonium	NH_4Cl.
6, Benzoate of ammonium	$NH_4C_7H_5O_2$

III. THE TAR.

1. *Hydrocarbons.*

	Formula.	Sp. Gr.	Boiling Points.	
1, Benzol	C_6H_6	·850	82°C.	=179·6°F.
2, Toluol, methyl-benzol	C_7H_8	·870	111°	=231·8°
3, Ethyl-benzol	C_8H_{10}	.....	132°	=269·6°
4, Xylol, dimethyl benzol	C_8H_{10}	·867	140°	=284·°
5, Cumol, propyl-benzol	C_9H_{12}	·870	153°	=307·4°
6, Methyl ethyl-benzol	C_9H_{12}	.....	160°	=320°
7, Tri-methyl-benzol (psendocumol, mesitylene	C_9H_{12}	.....	166°	=330·8°
8, Isobutyl-benzol	$C_{10}H_{14}$	.....	159°	=318·2°
9, Cymol, methyl-propyl benzol	$C_{10}H_{14}$	·861	178°	=352·4°
10, Di-ethyl-benzol	$C_{10}H_{14}$	.....	178°	=352·4°
11, Di methyl-ethyl benzol (ethyl-xylol	$C_{10}H_{14}$	.....	184°	=363·2°
12, Amyl benzol	$C_{11}H_{16}$	·859	193°	=379·4°
13, Methyl - amyl-benzol	$C_{12}H_{18}$	.....	213°	=415·4°
14, Di-methyl-amyl-benzol (amyl-xylol	$C_{12}H_{20}$	.....	232°	=449·6°
15, Phenylene	C_6H_4	.....	91°	=195·8°
16, Cinnamene, styrolene	C_8H_8	.924	145°	=293°
17, Naphthalene	$C_{10}H_8$	1·153	220°	=428°
18, Di-phenyl	$C_{12}H_{10}$	.....	240°	=464°
19, Anthracene	$C_{14}H_{10}$	1·147	300°	=572°
20, Pyrene	$C_{16}H_{10}$			
21, Chrysene	$C_{18}H_{12}$			
22, Benzerythrene. (*and probably*)				
23, Quintane	C_5H_{12}	0·60	30°	= 86°
24, Sextane	C_6H_{14}	·669	68°	=154·4°
25, Other paraffines	C_nH_{2n+2}			
26, Quintene, amylene	C_5H_{10}	.....	35°	= 95°
27, Sextene	C_6H_{12}	.....	68°	=154·4°
28, Other olifines	C_nH_{2n}			
29, Quintine, valerylene	C_5H_8	.....	46°	=114·8°
30, Sextine, diallyl	C_6H_{10}	.....	58°	=136·4°
31, Other acetylenes	C_nH_{2n-2}			
32, Dipropyl	$(C_3H_7)_2$	·678	68°	=154·4°
33, Dibutyl	$(C_4H_9)_2$	·706	106°	=222·8°
34, Diamyl	$(C_5H_{11})_2$	·741	158°	=316·4°
35, Dicaproyl	$(C_6H_{13})_2$	·757	202°	=395·6°
36, Other alcohol radicals	$(CnH_{2n+1})_2$			

2. *Alcohols.*

1, Phenol, carbolic acid	C_6H_5OH	1·065	180°C.	=356° F.
2, Cresol, cresylic acid	C_7H_7OH	.....	200°	=392°
3, Phlorol, phloryllic acid	C_8H_9OH	1·037	195°	=383°
4, Xylenol	C_8H_9OH	.....	213·5°	=416°
5, Thymol	$C_{10}H_{13}OH$	....	220°	=428°
6, Methyl-thymol	$C_{11}H_{15}OH$			
7, Ethyl-thymol	$C_{12}H_{17}OH$			
8, Amyl thymol	$C_{15}H_{23}OH$			

3. *Acids.*

1, Acetic	$H.C_2H_3O_2$	1·062	117·2°	=243°
2, Butyric	$H.C_4H_7O_2$	·9817	164°	=327·2°
3, Rosolic	$C_{20}H_{12}O_2$			
4, Brunolic	?			

4. *Bases.*

1, Ammonia	H_3N	Gas		
2, Methylamine	CH_5N	Gas		
3, Ethylamine	C_2H_7N	·696	19°	= 66
4, Diethylamine	$C_4H_{11}N$	.....	57·5°	=13
5, Aniline, phenylamine	C_6H_7N	1·028	182°	=35
6, Toluidine	C_8H_9N	.....	205°	=40
7, Xylidine	$C_9H_{11}N$	.....	215°	=41
8, Cumidine	$C_{10}H_{13}N$	·952	225°	=437°
9, Cymidine	$C_{11}H_{15}N$	·....	250°	=482°
10, Pyridine	C_5H_5N	·985	117°	=242·6°
11, Picoline	C_6H_7N	·961	133°	=271·4°
12, Lutidine	C_7H_9N	·946	154°	=309·2°
13, Collidine	$C_8H_{11}N$	·921	179°	=354·2°
14, Parvoline	$C_9H_{13}N$	.....	188°	=370·4°
15, Coridine	$C_{10}H_{15}N$	.....	211°	=411·8°
16, Rubidine	$C_{11}H_{17}N$	1·017	230°	=446°
17, Viridine	$C_{12}H_{19}N$	1·017	251°	=483·8°
18, Pyrrol	C_4H_5N	1·077	133°	=371·4°
19, Leucoline, chinline	C_9H_7N	1·081	238°	=460·4°
20, Iridoline, lepidine	$C_{10}H_9N$			
21, Cryptidine, dispoline	$C_{11}H_{11}N$		273·9°	=525°

5. *Pitch.*

Oxidized bituminous bodies whose nature has not been accurately determined.

IV. THE COKE.

	Per cent.
Carbon	90–95
Sulphide of iron (Fe_7S_8)	3–10
Ash	3–15

PURIFICATION.

The next thing in the operation of gas making is purification. The impurities which are not separated from the crude gas, either in the condenser, washer, or scrubber.

THE YIELD OF GAS COALS.

The quantities of gas, ammonia water, tar and coke obtained from coal vary according to the quality of the coal and the character of heats. Prof. J. Lawrence Smith, in his able report on the Paris Exposition, gives the following figures from the Imperial gas works in Paris, for the year 1866:

Coal carbonized	421,000 tons
Gas obtained	4,320,491,244 cu. ft.
Feet of gas per ton	10,262·5

Tar	21540 tons.
" per cent	5.356
" lbs. per ton of coal	119.97
" U. S. gals	12.6
Ammonia products	3000 tons.

This table, from the British *Journal of Gas-Lighting*, is interesting in this connection :

Table of the Products per Ton of Coal carbonized, realized by the Metropolitan Companies in year 1870.

Name of Company.	Coke per ton of coals, in bushels.	Breeze per ton of coals in bushels.	Tar per ton of coal in Gallons.	Ammoniacal Liquor per ton of Coals, in gallons.
Chartered	21.86	2.60	9.32	18.77
Commercial	25.76	3.63	8.31	13.78
Equitable	26.07	2.56	10.85	22.86
Imperial	26.63	4.05	8.38	13.52
Independent	20.45	1.14	9.70	13.08
London	29.36	3.21	9.24	12.08
Phœnix	28.67	1.80	9.67	17.80
Ratcliff	23.58	2.79	8.96	19.55
South Metropolitan	24.66	5.10	9.07	17.38
Surry Consumers	24.81	1.58	7.45	11.28
Western (cannel only)	8.18	7.46	12.16	12.43
Average	24.44	3.33	9.14	15.60
Average excluding Western Company	25.28	3.12	8.99	15.76

PURIFICATION.

The next thing in the operation of gas making is purification. The impurities which are not separated from the crude gas, either in the condenser, washer, or scrubber, are all more or less objectionable. All the sulphur compounds produce sulphurous acid and probably some sulphuric acid, when the gas is burned, which vitiate the atmosphere and may even cause serious damage to books and silks, and other textile fabrics. Ammonia is objectionable because it attacks the fittings, corrodes the meters, and fixes the stopcocks. It also has the property of holding tar in suspension. When burned it is partially converted into nitrous acid. Ammonia is, in some respects advantageous; it unites with the sulphuric acid produced during combustion, and forms harmless sulphate of ammonia; and it is also said to prevent the deposition of naphthaline in the mains. The nitrogen and oxygen which are generally present in gas, are supposed to be entirely due to atmospheric air, which unavoidably gains admission when retorts are charged, purifiers changed, etc. Nitrogen diminishes slightly the illuminating power of the gas, as it absorbs a portion of the heat of combustion, without contributing either heat or light. It may also form nitrous or nitric acid, and thus vitiate the atmosphere. Oxygen is more objectionable than nitrogen; it diminishes the illuminating power of the gas very materially. Carbonic acid also occasions a considerable loss of light: one per cent. of this gas is said to diminish the illuminating power of coal gas 5 per cent.

This table which I show you now, prepared by Firle, indicates the per centages of the impurities at different stages of the manufacture at Breslau :

In the gas from—	Carbonic Acid.	Sulphuretted hydrogen.	Ammonia.
1. The condenser	3.72	1.06	0.95
2. The scrubber	3.87	1.47	0.54
3. The Washer	3.39	0.56	0.00
4. The Laming purifier	3.33	0.36	0.00
5. The lime purifier	0.41	0.09	0.00

A. Buhe (*Jour. fur Gasbeleuchtung*, 1869, 420) has given more elaborate statements, among which are the following:

Gas from Zwickau Coal.

In the gas from—	Carb. Acid.	Sulphuretted Hydrogen.	Cyanogen.	Ammonia.
1. The hydraulic main	2.91	.23	.07	1.10
2. The condenser	3.88	.40	.07	.24
3. The scrubber	3.86	.44	.06	.15
4. The washer	3.64	.34	.09	.04
5. The purifiers	4.11	.00	.00	.00

Gas from Nettlesworth (England) Coal.

In the gas from	Carbonic Acid.	Sulphuretted Hydrogen.	Ammonia.
1. The hydraulic main	1.10	0.19	0.70
2. The condenser	1.04	0.09	0.88
3. The scrubber	1.00	0.10	0.66
4. The washer	0.98	0.01	0.39
5. The purifiers	1.13	0.00	0.00

METHODS OF PURIFICATION.

There are four methods of purifying gas, now in use :

1st. *The Wet Lime Process.*—This process involves passing the gas through milk of lime, It is the oldest process in use, and is very effective in removing both the sulphur compounds and the carbonic acid. It has been generally abandoned, however, on account of the difficulty of disposing of the foul milk of lime called "blue billy." Occurring as a liquid, the "blue billy" is not easily transported; and as it does not rapidly undergo oxidation, it is not well adapted for use as a fertilizer. Running it into rivers and streams has been forbidden by law, as the pollution of the waters by it was intolerable, while the extremely offensivee smell which it emits, makes it impossible to store it until it becomes dry enough for transportation.

2nd. *The Dry Lime Process.*—In this process dry or slightly moist hydrate of lime is placed on trays in iron boxes, through which the gas is made to pass. This process is very effective, and has very generally superseded the wet lime process. It removes the sulphur compounds and the carbonic acid equally well. When the foul lime is removed, however, it evolves the same odor which caused the wet lime process to be abandoned. When exposed to the air it rapidly undergoes oxidation, becoming heated in consequence. During this process it evolves sulphide of ammonium, and some other compounds whose exact nature is not known, but whose odor is extremely offensive. This is the cause of the "gas nuisance" so loudly complained of a few years ago, when all the New York companies employed this process of purification. After the oxidation of the foul lime is completed, it ceases to be specially offensive, the peculiar stench being evolved during the first hour or two of exposure. The offensiveness of this foul lime became such a constant cause of complaint in the large cities of Europe that the gas companies were compelled to abandon the process, as they had previously abandoned the wet lime. A system of ventilating the foul lime has been invented, and is now in use at both the stations of the Manhattan Company in New York, which effects its oxidation in such a manner that the offensive gases evolved are not permitted to escape into the atmosphere, but are passed through a washing apparatus and finally through a special purifier by which they are rendered comparatively inoffensive. This invention seems to obviate the nuisance of dry-lime purification.

3rd. *The Laming Process.*—In 1849 Mr Laming introduced the hydrated sesquioxide of iron as a substitute for lime for purifying gas, and prepared it of a suitable quality, by mixing copperas (sulphate of iron) with slaked lime and saw-dust, and exposing the mixture to the air to oxidize the protoxide of iron to the sesquioxide. The resulting mixture contains hydrated sesquioxide of iron, sulphate of lime and sawdust. When an excess of hydrate of lime is employed, the resulting mixture contains this substance also. This material is very effective in removing the sulphur compounds from the gas. There is, however, some difference of opinion as to the completeness with which the carbonic acid is removed, due, perhaps, to variations in the proportion of the ingredients. Two important advantages attend the use of this mixture: first, when fouled it does not evolve offensive odors on exposure to the air; second, by exposure to the air the sesquioxide of iron, which has been changed to sulphide of iron in the purifier, is regenerated, the sulphur being liberated and sesquioxide of iron again formed. The mixture may, therefore, be used again and again, till it becomes so clogged with the sulphur liberated, that it does not act promptly on the gas. It is then found to contain from 40 to 60 per cent. of sulphur, and may be used for the manufacture of sulphuric acid. I have seen mixtures which had been in use twelve months.

4th. *The Iron Ore Process.*—A few months after Laming introduced the artificial sesquioxide of iron in France, Mr. J. M. Hills applied the natural hydrated sesquioxide of iron, or "bog iron ore" in England. This material, like the Laming mixture, may be used again and again, and does not evolve offensive odors when exposed to the air. A modification of this process is now used by the New York Gas Co. It was invented by Messrs. St. John and Cartwright, and has been in use nearly seven years, giving entire satisfaction. As the bog iron ores of this neigeborhood are not sufficiently pulverulent to act promptly on the gas, Messrs. St. John and Cartwright add to the ore a quantity of iron borings or turnings, which they then convert into an artificial hydrated sesquioxide of iron, moistening the whole with ammoniacal liquor and exposing it to the air. The resulting mixture of natural and artificial oxide, receives an addition of coarsly pulverized charcoal, This mixture is always sprinkled with ammoniacal water before it is placed in the purifier. In Germany several varieties of sesquioxide of iron are now in use, prominent among which are "the Oberuseler mixture," an iron ore containing some oxide of manganese; the "Mannheim oxide," and "Eeicke's oxide," very pure artificial oxides of iron.

Extent to which the different Methods of Purification are Employed.—The wet-lime method has been almost entirely abandoned. The only works at which I know it to be used at present are at Cork, in Ireland. These works are of moderate size, and are situated out of the city. Moreover, the gas is freed from ammonia by means of sulphuric acid before it comes in contact with the lime. The foul lime does not, therefore, evolve suiphide of ammonium when exposed to the air. The dry lime process, though still in general use in this country, has been almost universally abandoned in Europe—abandoned, firstly, because the foul lime was an intolerable nuisance; secondly, because the process is too expensive, as the lime can be used but once, and when exhausted has but a trifling value as a fertilizer. The Laming mixture is now used in some of the European gasworks. All the gas supplied to Paris is purified by this material. The German gas engineers have found that this mixture owes its efficacy entirely to the oxide of iron which it contains, and that the sulphate and hydrate of lime present do not take any appreciable part in the purification. Hence they are abandoning this mixture for the artificial oxides of iron, which are cheaper and more efficient. The iron ore method is now most generally used in Europe, and has obtained a foothold in this country, being used by the New York Gas-Light Co., the Harlem Company, and several companies in Massachusetts and elsewhere. All the Liverpool gas, much if not all of the London gas, and that of most of the German cities, is now purified either by iron ore or one of the artificial oxides of iron.

Comparative advantages of the different methods.—The lime methods effectually remove the carbonic acid, and reduce the sulphur compounds to a minimum. Were there no objections to the use of dry lime on the score of cost or offensiveness, I think this agent would be generally preferred. Lime was first abandoned on account of the nuisance which it occasioned, but the iron oxides are now actually preferred by the European gas engineers on account of their

greater economy. Mr. King, the engineer of the Liverpool works, assured me that the oxide of iron purification, which he had used exclusively for the past 7 or 8 years, costs less than half as much as the dry lime process used previously. Two objections are urged against the iron methods by those who are prejudiced in favor of lime. First, they do not remove carbonic acid; second, it is claimed that they do not remove the sulphur compounds as completely as lime. The first is generally conceded to be true. But the only objection to carbonic acid is that it reduces the illuminating power of the gas: 1 per cent. of carbonic acid diminishes the illuminating power 5 per cent. The average quantity of carbonic acid is say 2½ per cent.; then the illuminating power of the gas will suffer to the extent of 12½ per cent., or one-eighth. There are two ways in which this difficulty can be effectually met: First, by using better coals for making the gas, or adding a few pounds of rich cannel or some other enriching material to the ordinary gas coals; or secondly, by taking less gas from the coal. The last gas drawn from the coal is always inferior to that which comes off first. Mr. A. Buhe, already referred to, says: "It has become more and more the custom to leave the carbonic acid in the gas, and to neutralize its bad influence on the illuminating power by taking less gas from the coal, thus getting a better gas." Dr. Schilling says: "Carbonic acid is of no consequence to the consumer; cannel coal is the remedy." The second objection to the iron processes is the alleged imperfect removal of the sulphur compounds. None of the methods in use entirely remove the sulphur from the gas. The question arises, therefore, how much sulphur can be safely left in the gas? The English Parliament has answered this question by fixing the limit at 20 grains of sulphur to the 100 cubic feet of gas; and to see that the companies come within this limit, chemists are appointed whose duty it is to analyze the gas and report its quality. I have before me the report of Dr. Letheby for the months of Jan., Feb., and Mar., 1869. He states the grains of sulphur found in 100 cubic feet of gas to be as follows:

	Maximum	Minimum	Average
City of London Gas-Light and Coke Co...	18·92	11·70	15·00
The Gas-Light and Coke Company.....	24·15	15·75	19·49
Great Central Gas Consumers' Company.....	24·00	7 03	12 28

From this it will be seen that the gas of London, although purified by iron, does not average 20 grains of sulphur in 100 cubic feet. With regard to the Paris gas, which is purified by Laming's oxide of iron mixture, Prof. J. Lawrence Smith, one of the U. S. commissioners to the French Exposition of 1867, who is the president of the Louisville gas company, has given us a very decided opinion. On page 88 of his report, which was published by the U. S. government, he says: "The gas of these works is most thoroughly purified, and the dealers in silks and other delicate fabrics, who, a few years ago, always suffered more or less loss from the results of the combustion of impure gas acting on their fabrics, now no longer suffer from this cause." Dr. Letheby (*Journal of Gas-Lighting*, 1869, p. 83) has argued that 20 grains of sulphur should not be left in the gas, and proposes, therefore, as the most effective method of purifying gas, this treatment: first, with ammoniacal liquor; second, with hydrated oxide of iron; third, with dry lime. As the iron will have removed the sulphuretted hydrogen, the refuse lime will not be offensive, while it will effectually remove the carbonic acid. This system of purification will, he thinks, reduce the quantity of sulphur to 10 or 12 grains per 100 cubic feet. Most gas engineers and chemists differ from Dr. Letheby on this point, however. Dr. Schilling says (in his *Journal fur Gasbeleuchtung* for 1869, p. 484): "20 grains of sulphur in 100 cubic feet of gas are entirely unobjectionable. Under the most favorable circumstances, with no ventilation whatever, it would give the atmosphere of a room only 1 part of sulphurous acid in 500,000 parts of air." Prof. Wm. Odling, secretary of the London Chemical Society, has spoken very clearly on this subject in his lecture to the British Association of Gas Managers, June 2, 1868, which appears in the *Journal of Gas-Lighting* for 1869, p. 81, and I have found that his views are those generally entertainee by chemists and gas engineers. He said: "I am altogether at issue with the public when they maintain that the sulphur of gas produces, by its combustion, oil of vitriol, or that the amount of sulphur ordinarily contained in gas is of any consequence whatever; and a little consideration will, I think, satisfy you of the soundness of this position. We will assume that coal-gas contains not 20, but 40 grains of sulphur in one hundred feet—a quantity at any rate greatly exceeding the reality. Now, making another extravagant assumption that the whole of these 40 grs. of sulphur would be completely burned—and in reality they would be burned very incompletely—they would furnish, by their combustion, 80 grains of sulphurous acid gas. This quantity of the preduced sulphurous acid would occupy at ordinary temperatures about 1-15th part of a cubic foot, and since 100 cubic feet of our coal-gas gives 1-15th of a cubic foot of sulphurous acid, 1,500 cubic feet of coal-gas would be required to furnish one cubic foot of the acid, even upon the extravagant assumptions we have purposely made. But the combustion of 1500 feet of coal gas would produce something besides sulphurous acid. It would produce at least 1000 cubic feet of carbonic acid, and, in addition to its dilution by other gases and vapors, we should have our sulphurous acid diluted by 1000 times its volume of carbonic acid. Now, if we can get at the proportion of carbonic acid in the atmosphere of a room highly illuminated with gas, and take the 1-1000th part of that proportion, we shall be able to form some notion of the amount of sulphurous acid present. You will remember that the amount of carbonic acid furnished by the breath of one individual is equal to that furnished by two 3-feet gas burners, and that the maximum amount of carbonic acid found in the atmosphere of a crowded theatre was 0·32 per cent. Now, if in addition to our previous unreasonable suppositions, we further suppose that an atmosphere contains 0·2 per cent of carbonic acid furnished by gas combustion, you will see that the whole matter becomes a *reductio ad absurdum*—that we might actually have one-half millionth part of sulphurous acid present in the air of a gas-lighted room." The facts and opinions here quoted effectually dispose of the second objection to oxide of iron purification.

Composition of the purified gas.—The following table shows the percentage composition of the purified coal-gas as it is delivered to consumers:

	Heidelberg.	Bonn	Chemnitz	London common.	London cannel.
Hydrogen.	44.00	39.60	51.29	46.00	27.70
Marsh-gas.....	38.40	43.12	36.45	39.50	50.00
Carbonic oxide.	5.73	4.66	4.45	7.50	6.80
Olefiant gas and other hydrocarbons.....	7.27	4.75	4.91	3.80	13.00
Nitrogen.....	4.23	4.65	1.41	0.50	0.40
Oxygen	—	—	0.41	—	—
Carbonic acid .	0.37	3.02	1.08	0.70	0.10
Aqueous vapor..	—	—	—	2.00	2.00

The difference in the percentages of carbonic acid is largely due to the method of purification. When lime is used, nearly all of this gas is removed, otherwise not. As the specific gravity or density of the hydrogen and marsh-gas is much less than that of olefiant gas and the rich hydrocarbon vapors, the sp. gr. of the gas made from the same coal, is a tolerably accurate measure of its richness in illuminating constituents. The specif. grav. of air is taken at unity (1·000), hydrogen is 0·0691; marsh gas, 0·5594; carbonic oxide, 0·9727; olefiant gas, 0·976; propene, 1·490; and butene, 1·940; benzole and other rich vapors, much higher. Hughes in his treatise on gas works gives the following estimate of the specific gravities of gases of different illuminating powers: 12-candle gas ·400; 14-candle, ·425; 16-candle, ·450; 18 candle, ·475; 20-candle, ·500, etc. This would not be even approximate for gas containing much carbonic oxide, as that prepared by the aid of steam. Mr. W. W. Goodwin, of Philadelphia, now supplies a beautiful and simple piece of apparatus by which the specific gravity of the gas can be accurately determined in a few minutes.

As it is sometimes desirable to estimate the yield of gas from coals in percentages by weight, the following data will be useful: (1) the specific gravity is the ratio of weight compared to that of air as a unit; (2) 1000 cubic feet of air weigh 76·708 pounds avoirdupois; (3) multiply 76·708 by the specific gravity, and the product is the weight of 100 cubic feet of the gas. Hydrogen has a specific gravity of ·0691; 76·708 × ·0691 = 5·30 pounds; marsh-gas = specific gravity ·5594; 1000 cubic feet weigh 42·91 pounds; 1000 cubic feet carbonic oxide, specific gravity, ·9727=74·61 pounds; 1000 cubic feet olefiant gas, specific gravity, ·976=74·86 pounds.

Before leaving the subject of the composition of gas I desire to call your attention to this simple terrace of burners. The upper row of burners shows you the flames of pure hydrogen, which are so low in illuminating power that you can hardly see them. The second row is supplied with marsh-gas; you see that the flames are yellow, but that they emit very little light. The third row presents the carbonic oxide flames which are of a livid blue, like the flames of this same gas which often flit across our anthracite fires. What a contrast is presented by the lower row of burners, from which the pure olefiant gas issues. That this gas is the source of the illuminating power, and that hydrogen, marsh gas, and carbonic oxide are mere diluents, you can no longer doubt.

MAINS.

In the distribution of gas a certain percentage o leakage is unavoidable, but this can be reduced to a minimum by the exercise of a little care. The best plan is to test each length of pipe by closing one end with a plug, connecting the other end with a small forcing air-pump, such as is used by gas-fitters, and while the pipe is immersed in water forcing air into it. Bubbles of air passing the pipe will reveal every imperfection in the metal.

The location of each leak can be recorded by making a circle around it with chalk. Small holes can be closed by hammering the metal together; if large holes are detected, the pipe should be rejected. Immersing the pipes in hot coal-tar is a very effective preventive of leakage. Leakage is said to often amount to 16 per cent. of all the gas produced, or even more; by the above-mentioned precautions it may be reduced to 2 per cent. As there is always a certain condensation of water and oily or tarry matter in the mains, receivers or *wells* are constructed at convenient points, and the mains are laid inclining towards them. From time to time the condensed liquids are pumped out of the wells into a portable tank and thrown into the tar well at the works. Complaint is sometimes made of an excessive condensation of naphthaline in crystals or crusts, which seriously diminish the capacity of the pipes. According to J. Lawrence Smith, bitumenized iron pipe is extensively used for gas in France. It is made from 1¾ to 28 inches in diameter. The base of the pipe is sheet-iron, leaded, varying in thickness according to the required size and pressure; each section of pipe is made of two sheets, that are first riveted together separately with tinned rivets, and plunged into a bath of melted lead; these two pieces of pipe are then riveted together, and the junction of the two well tinned. The entire pipe is now 13 feet long. On the ends are convenient sockets and spigots, made of a mixture of lead and antimony, which serve to unite the sections of pipe when laid in the ground. The exterior surface of the pipe is coated with tar, and around this is wrapped a cord; this cord is then covered with melted pitch, and the pipe then rolled in coarse sand until it has acquired a thickness of from one-fourth to five-eighths of an inch. Chameroy & Company of Paris manufactured between the years 1838 and 1867, of this pipe for gas, 3160 miles; for water, 897 miles—of a total value of $7,708,400.

THE METERS.

Nothing is so mysterious to the gas consumer as

the meter, and yet, as a matter of fact, the meter is quite as accurate as any other measure in use. It does sometimes err, but its errors are almost always in favor of the consumer and against the companies. It cannot measure gas that does not pass through it, but may permit gas to pass through without registering the quantity.

It is unnecessary to explain the construction or working of the meter to this audience. I will say, however, that the measurment of gas presents difficulties not encountered in any other case. The gas must be measured while in actual use, as no system of measurement and storage would be practical. Its flow must not be interrupted in the slightest degree, as otherwise the lights would be extinguished, or at least be made to flicker in a manner that would be unendurable, and while its flow is uninterrupted, its volume must be accurately recorded.

COMPARATIVE ADVANTAGES OF WET AND DRY METERS.

Wet meters being simpler in construction, composed entirely of metal, and having no valves except the float, are most durable and less likely to get out of order. Thev are, however, liable to stop from freezing, from too much or too little water, and from sending moisture into the pipes. They also register vapor of water as gas, though the quantity is too small to be of any consequence. The dry meter is not liable to any of these objections, but being more complicated and more delicate, it is more liable to wear and to get out of order. The inaccuracies which result from wear or corrosion are generally in favor of the consumer, as gas leaks from one space to another and escapes being measured. The dry meter is now more generally used.

The accuracy of the meters is very often questioned by the consumers. The resemblance of the dials lead them to infer that, like clocks, the meters may run fast or slow. But the case is not parallel; the meter is an engine in which the gas is the motive power, and unless the gas passes through the meter, it cannot move. On its dials are faithfully recorded the number of its revolutions in cubic feet. All waste and leakage is recorded as well as the useful consumption. Some think that the increased pressure makes the meter spin round faster and record against the consumer; but if he regulates the burners so as to prevent "blowing," he at once neutralizes the effect of the increased pressure. From the nature of things, the injury which the meter suffers in use must generally be against the company. If a valve leaks or a rust hole occurs in the measuring-drum, or a crack in the leather, gas gets through without being recorded. Sometimes the valves of a dry meter become fixed in such a position as to let the gas through without moving. The meters are all tested by State inspectors by passing a certain number of cubic feet through each, and noting whether it is properly recorded on the dials. In New York and Massachusetts a meter is stamped correct when it varies less than 2 per cent; in Ohio the tolerance is 3 per cent. Prof. Wormley, State inspector for Ohio, in testing 2321 new meters found only 13 that varied over one-half of 1 per cent. Mr. Stimpson, State inspector in Massathusetts, in one yeur tested 11,316 meters; only 148 failed to come within the requirements of the law. Very few of these varied 5 per cent.; 62 averaged 8.47 per cent. against the companies; and 85 averaged 4.5 per cent. short.

BURNERS.

Far too little attention is paid to the character of the burners. There are three forms of burner in common use, the "bat-wing" or slit-burner, the "fish-tail," and the "argand."

The amount of light produced by a given gas varies enormously with the conditions under which it is burned The maximum amount of light is obtained by burning it on the verge of smoking, while in the Bunsen burner, used for heating purposes in chemical laboratories, the flame is blue and non-luminous. The loss of light is due to a too rapid mixing or contact of the gas with the air. This is controlled by the size and shape of the holes in the burner, the height of the chimney, and the distribution of the air (in the argand), and in all cases by the pressure. The holes and slits for rich gas should be small, as such gas requires more air than poor gas. Under the same pressure a burner which consumes four feet of gas per hour gives more light than two burners consuming each two feet. There is no economy of light in small burners. The pressure of the gas is a most important consideration. Argands give most light under a pressure of 1-10th inch, bat-wings and fish-tails under a pressure of 3-10th to 4-10th inch. As gas is supplied to consumers under pressure varying from 3 or 4 inches down to 1-10th, it is very desirable to check the flow of gas when it is excessive. This can be done by the use of regulators, by turning the gas off ot the meter, by partly closing the cocks on the fixtures, or by introducing a check into the burner. Check-burners should always be used; they are constructed in various ways--always by placing some obstruction in teh way of the gas to retard its escape. A very simple plan is to screw a five or six foot burner over a three or four foot burner. With regard to a choice of form, the *argand* is best for ordinary gas; it gives a very steady flame and consumes the gas to the best advantage.

Batwing burners cannot be used in globes or shades, as the flame is so broad as to crack the glass; *fish-tails*, or the peculiar form of bat-wing burner known as having the "excavated head" must be employed. The material of which the burner is constructed is a matter of great importance, iron rusts and the size and form of the openings become considerably modified in consequence; brass is better, but the best material is soap stone, usvally called "lava," The best burner is Sugg's London burner, a lava argand. The best burner to be had in this country is Gleason's noiseless argand, of brass, provided with a regulator, which serves as a check. Most of the "patent burners" possess very little value, the merit generally consists in a check of some kind; none of them are equal to the properly constructed lava tipped bat wings, fish-tails, and argands, provided with simple checks. Some of you remember the monstrous swindle which was attempted a few years ago in this city with the Cremin burner. It was proposod to place this patent burner, together with a tin reflector, the whole costing perhaps a dollar and a half, on every public lamp, at a cost to the city of $15 each. As there are about twenty thousand street lights, the swindle would have cost the city $300,000, without furnishing any additional light. The head of the department of Public Works at that time, Mr. Tweed, refused to countenance such a fraud, and the scheme failed in consequence.

The gas referees of London made a report in 1871 on the subject of burners, in which some points are established which are of great importance. They found that by using good burners instead of bad ones, consumers may obtain from 30 to 50 per cent. more light while their gas bills remain the same. The improvement of burners is important as a sanitary reform, as in furnishing the same quantity of light the good burner will consume less gas and consequently air and will produce a smaller quantity of the products of combustion, and less heat than a poor burner. Burners from two newspaper offices gave only half the illuminating power of the gas, while several of the burners tested gave only one quarter the roper light of the gas.

These facts and many others which came to their knowledge proved to the referees that "an enormous waste of gas prevails, with a corresponding pecuniary loss to the public."

London pays $10,000,000 per annum for gas, and the referees believe that one fourth this sum may be saved by the use of good burners.

The best burner yet constructed is "Sugg's London Burner" (argand, lava), calling the illuminating power of its flame, when consuming 5 feet of 15 candle gas per hour, 100, the following were the best results obtained from several burners

FISH-TAIL BURNERS.

	Pressure Inches	Consumption of gas per hour.	Illum. Power. Sugg's Lond. No. 1. at 5 feet. =100.	Illum. Power. Calc'd to a consumption of 5 feet.
No. 1.....	6·2	1·7	12·2	36·
" 2.....	0·3	3·1	38·4	62.
" 3.....	0·45	3·3	34·3	52·
" 4.....	0·17	2·	18·8	47·
" 5.....	0·5	1·8	6·8	19·
BAT WING BURNERS.				
" 7.....	0·3	5·	86·5	86·5
" 8.....	0·3	4·9	75·6	82·2
ARGAND BURNERS.				
" 9 Sugg's Lond. No. 1	0·218	5·	100.	100·
" 10 Common..	0·22	5·6	89·1	78·8
" 11 "	0·78	5·8	90·6	77·4
" 12 "	0·6	5·2	34·7	34·3

It is thus seen that the six bat wing burners tested, burned under the most favorable pressures for each, gave only from 19 to 62 per cent. as much light as Sugg's London burner, for the same consumption of gas, five feet per hour: the two bat wing burners from 82·2 to 86·5 per cent., and the three Argands from 34·3 to 78·8 per cent.

[To be concluded.]

On the Value of Petroleum and Coal-Tar in the Manufacture of Coal-Gas.

By Professor A, Wagner.

[Translated from "Dingler," vol. 217, p. 64, by T. H. Muller.]

As was stated in a previous article, refined petroleum was distilled after it had been freed from all components boiling below 150° Celsius. Its vapor was conducted through a red hot porcelain tube, filled with broken pumice stone, thence through a condenser. Part of the vapors condensed, part of them were transformed into gas. When the temperature of the retort reached 288°, the experiment was stopped; one-third remained in the retort, one-third in the condenser, and one-third was transformed into gas. The petroleum used might therefore be considered as not the best quality of burning oil for lamps, on account of the large percentage of fractions boiling at too high a temperature- The results were as follows:

	Sp. gr.	Boiling point.	Carbon per cent.	Hydro g. per cent.
Petroleum used	0.789	150 to +360	85.7	14.3
Left in retort...	0.830	288 to +360	85.2	14.8
In condenser...	0.780	110—190	83.0	17.0

The original combination of petroleum with 85·7 carbon, is exactly in accordance with C_2H_4, that of heavy hydrocarbon gas, which also contains 85·7 per cent. carbon and 14·3 hydrogen.

The remainder in the retort, with much paraffine, is analogons to a mixture of petroleum and paraffine. The latter produced from raw petroleum has, according to Anderson, 85·15 per cent. carbon.

The combinations of the condensed part boiling from 110—150, with 83·3 per cent. of carbon, are similar to those of naphtha, for which the author found 83·3 per cent. carbon, and is nearest to the combination isolated by Schorlemmer from crude Pennsylvania petroleum "Pentan," C_5H_{12}, to which belongs an amount of carbon equal to 83·3 per cent.

As it was shown above, one-third of the petroleum was transformed into gas, and since the remainder in the retort, as well as the condensed part, passess less carbon than the original oil, it is also shown that the parts richest in carbon were transformed into gas.

But by no means is this carbon all contained in the gas, which, in that case, must possess at least the amount of carbon contained in heavy hydrocarbon gas; but a considerable part is decomposed producing a deposit of carbon.

According to Keim, gas produced in Hirzel's apparatus, from petroleum refuse, consisted of 17·4 per cent. heavy hydrocarbon gas, 58·3 per cent. light hydrocarbon gas, and 24·3 per cent. hydrogen. Now, as heavy hydrocarbon gas contains 85 per cent. carbon, and light hydrocarbon gas 75 per cent. carbon, the gas contains less carbon, and, therefore, more hydrogen than would belong to the petroleum refuse with 85 per cent. carbon.

According to Kolbe, Hirzel's petroleum gas consists mainly of acetylene, C_2H_2, with 92·3 per cent. carbon.

The author made an analysis of petroleum gas, with the following results:

The gas was produced by conducting the vapors of petroleum through the wrought iron tube (30 inches in length) described in a previous article, heated to a bright red for the entire length, and filled with pumice stone. The gas gave, with an ammoniacal solution of chloride of copper (Cu_2ClH_2N) at once the well-known reddish-brown deposit of acetylene copper; and with an ammoniacal solution of nitrate of silver, the grayish-white deposit of acetylene silver. The quantitative analysis gave 5·0 per cent. by volume acetylene, and 35·96 heavy hydrocarbon gas The remaining 59 per cent by volume consisted mainly of light hydrocarbon gas, and burned with a yellow flame of low luminosity.

Probably the petroleum is at a high temperature, at first transformed into heavy hydrocarbon gas, which has the same chemical combination, and is there partially split up, according to $C_2H_4=CH_4+C$, into light hydrocarbon gas accompanied by a deposit of carbon, and part of this light gas, according $(CH_4)_2=C_2H_2+H_6$, into acetylene and hydrogen.

If the petroleum had been transformed directly into heavy hydrocarbon gas, without undergoing decomposition and transformation, one gramme petroleum should have given 0·80 litre gas; but as the author received from 1·375 gramme petroleum 1·205 litre gas, and from 0·330 gramme petroleum 0·290 litre gas, the oil actually gave per gramme 0·876 litre gas (both experiments alike) that is a larger amount than if the oil had only furnished heavy gas.

If the petroleum or the heavy hydrocarbon gas formed therefrom had been entirely "split up," according to $C_2H_4=CH_4+C$, into light hydrocarbon and deposited carbon, one gramme petroleum should have furnished 0·792 litre light hydrocarbon, and 0·428 gramme deposited carbon. But it is well-known that the decomposition of petroleum vapor in red-hot tubes is much more complicated, there is formed besides deposited carbon and light hydrocarbon gas, acetylene, naphthaline, hydrogen, etc. Acetylene itself "splits up" at a high temperature into benzol, styrol, naphthaline, etc. If the splitting up of the petroleum or the heavy hydrocarbon gas formed therefrom would take place in the most simple form possible, according to $C_2H_4=C_2H_2+H_2$ into acetylene or hydrogen, the products of one gramme petroleum should be 0·798 litre acetylene gas and 0·797 litre hydrogen gas, *i. e.*, a total of 1.595 litres of gas. If the decomposition would take place according to the more probable equation—

$$(C_2H_4)_2=2(CH_4+C)=C_2+C_2H_2+H_6$$

the result would be at perfect decomposition, according to this equation, 0·398 litre acetylene gas and 1·194 litre hydrogen equal 1·592 litres of gas, besides 0·428 grains deposited carbon.

This last equation explains why petroleum furnishes at a high temperature a much larger volume of gas than would be possible under simple splitting up into light and heavy hydrocarbon gas.

The most probable assumption, therefore, according to these experiments, is that the petroleum is split up at high temperatures, under deposition of carbon, into a mixture of acetylene gas, heavy and light hydrocarbon gas and hydrogen. A simple transformation into acetylene and hydrogen is not probable, as the amount of gas in this case would be larger than that obtained by experiment.

The author further describes experiments made with naphtha, in relation to obtaining permanent gas. The naphtha employed was 0·676 sp. gr., and contained hydrocarbons, boiling at 30°C, beside considerable quantities of such boiling up to 100°.

The elementary analysis showed 83·3 per cent. of carb n and 16·7 per cent hydrogen; it contained, therefore, elements with less carbon than the refined petroleum as well as the petroleum refuse. The combination agrees very closely with the Pentan C_5H_{12}, by Schorlemmer, from Pennsylvania petroleum.

In order to test the quality for gas-making, the vapors were conducted through the previously described tube filled with pumice stone, heated to redness. After passing through a condenser cooled with snow, the gas was collected over water of 0° into a graduated glass cylinder, also surrounded by snow. After the gas had acquired the temperature of 0°, the volumes were read off as follows: 1·920 gramme naphtha—1·76 litre gas=50 kilog. naphtha equal 1619 cubic feet gas. Naphtha, therefore, furnished a remarkably larger quantity of gas than refined petroleum, the gas being of excellent quality.

Since the naphtha may be obtained at a considerably lower price than the refined oil, it is very probable that the same may be used advantageously in gas-making; but, at the same time, the utmost care must be employed in handling, and constructing the plant, to guard against the dangers of fire and explosion.

The author further speaks of the value of coal tar for producing permanent gas. As the Saarbruck coal gives in gas making about 15 per cent gas and 5 per cent tar (consisting of 2—10 per ct. light and 15 to 30 per cent heavy coal-tar oils, and "Goudron"). There have been numerous experiments to utilize the same for the manufacture of gas.

Tar by itself not proving very promising, most experiments were directed to effect the change of volatile hydrocarbons to permanent gas by the addition of lime and steam. Amongst others Vere & Crane in 1823 injected steam into a retort where coal, tar, tar-oils, etc., were being distilled or carbonized. In 1843, Malam used steam and tar vapors; in 1861, Prince distills tar and steam over red hot coal; in 1862, Cormack employed tar, petroleum, oil, etc., with steam; in 1867, Salmon, the same, besides numerous other trials without favorable results.

The results of experiments, made by the author to ascertain the value of tar and tar-oils for gas-making, under different conditions, are as follows:

Materials carbonized	Gas received from 100 lbs. tar or tar oils.	Properties of the Gas—it burned with.
Coal tar alone....	143 cub. ft.	Low luminosity like light hydrocarbon gas,
Light coal tar oil 130 deg. boiling point.....	131 "	Moderately luminous, like poor illuminating gas
Heavy coal tar oil above 160 deg. boiling point...	342 "	Bright, luminous.
Goudron (Asphalt) free from components boiling below 230 deg.....	229 "	Less luminous, like marsh gas.
Coal tar & steam.	301 "	" " "
Coal tar with slaked lime and steam.....	1519 "	Non-luminous.
Coal tar and slaked lime.....	217 "	Blue, non-luminous.

This shows that none of these methods admit of the production of gas from tar; most advantageous is the heavy coal-tar oil, the least so is the light oil containing principally benzol, a phenomena which may find its explanation in the fact that the benzol being formed at high temperatures is consequently stable at these temperatures. While the hydrocarbons of raw petroleum with, from 83 to 86 per cent. carbon are easily transformed into permanent gas, those of the benzol class with 92.3 per cent. carbon, do not possess those properties. But inversely can all constituents of illuminating gas, whether produced from coal, petroleum, or any other material—that is, light and heavy hydrocarbon gas, acetylene, and carbonic oxide—form benzol at high temperatures. The heavy hydrocarbon transforms under disengagement of carbon into light hydrocarbon, the latter under formation of hydrogen into acetylene. Carbonic oxide and light hydrocarbon form by heat acetylene and water, and the acetylene at very high temperatures then forms benzol. There must therefore also be formed, during the formation of gas from petroleum, also a certain quantity of benzol.

Estimating the Horse Power of Steam Engines.

When steam engines were first introduced they were largely used to take the place of the horses before employed for raising water from mines. Naturally, people asked when buying an engine how much work would it do; that is, how many horses did it represent. The early engine builders found themselves greatly at a loss when this question was first asked. They had at once, therefore, to determine how many horses an engine was equal to. The first thing was to find out how much a horse could do. The strongest English horses, the London brewers' horses, were far above the very best that could be found elsewhere. They were found to be able to travel at the rate of 2½ miles per hour, and work eight hours per day. The load was pulling a 100 pound weight up out of a shaft by means of a rope. When a horse moves 2½ miles per hour he travels 220 feet per minute, and of course, at this speed, the 150 pounds would be raised vertically that distance. That is equal to 300 pounds lifted 110 feet high per minute, or 3,000 pounds 11 feet, or 33,000 pounds 1 foot high in one minute. This 33,000 pounds lifted one foot high every minute is taken as a standard horse-power. It is much more than any ordinary horse can do, and, therefore, the engine builders were always sure that their engines would take the place of fully as many horses as the horse power would indicate that they should. Of course 33,000 pounds lifted one foot per minute is much more convenient for calculation than 150 pounds 220 feet, and, therefore, the former form has been adopted. The amount of work. or number of foot pounds, however, is just the same in either case. "A foot pound" represents the amount of power required to lift one pound one foot high. It is comparatively easy to estimate the horse power of an engine with a reasonable degree of accuracy, provided we know certain things in regard to it. We must know the pressure in the boiler, the diameter of the cylinder, the length of stroke, the number of revolutions per minute which the engine is making, and, lastly, the point at which steam is cut off.

When there is no cut off, steam is admitted into the cylinder during the whole stroke, and a cylinder full of steam at boiler pressure, is used at each stroke, as steam is "cut off" before the piston has reached the end of the cylinder. If steam is prevented from entering the cylinder after the piston has passed the middle of the stroke, the point of "cutting off" is at half stroke. If the steam enters the cylinder during three-fourths of the stroke and is then arrested, the point of cutting off is three-fourths of the stroke. It is necessary to know the point of cutting off, in order to find out what the average pressure is in the cylinder. In the commoner sorts of engines not provided with independent cut-off valves, the point of cutting off may usually be taken at from one-half to three-fourths of the stroke, though sometimes more than this. It may, perhaps, be safe to take the average pressure in the cylinder at about eight-tenths of that in the boiler, though where the steam pipe is long and the throttle valve is used to control the speed, the average pressure in the cylinder may be no more

than three-fourths of that in the boiler. The power will be the distance which the piston under this pressure travels during one minute. Therefore, we have the rule; multiply the area of the piston by the average pressure per square inch upon the piston, multiply this result by the distance which the piston travels per minute in feet, and the result is the number of foot-pounds per minute which that engine can raise. Divide by 33,000 and the result is the number of horse power. The number of feet per minute traveled by the piston is twice the number of strokes per minute multiplied by the length of stroke. This gives the number of horse-power sufficiently near for all practical purposes.—*Sawerd's Coal Trade Journal.*

Correspondence

[Correspondents, in all cases, should sign their communications with their names and address in full—not necessarily for publication, but as a guarantee of good faith.—Ed.

American Street Loss Accounts.

San Francisco, November, 1875.

Mr. Editor: While the responses to my request for street loss data have not been as general as I hoped, ome eight or ten of the largest companies have furnished official data, together with carefully digested comments thereon. I am permitted to forward you several of these letters—suppressing names. etc.; and I have good hopes of being the medium through which many others will reach you for publication.

To some of them a few remarks will be added; but each will be given in unmutillated form, so that the reader may make his own application. Should the example thus set have the effect of inducing a *general* compliance with my request, a mass of matter will gradually be built up, well worthy of stereotyping and final issue in pamphlet form.

After this brief preamble, I give you a few of the letters referred to.

A.

October 4, 1875.

James R. Smedberg, Esq.

My dear Sir: Yours of September 24, duly received. The only gas works of note of which I can speak from positive knowledge is * * * and our results for 1874 were as follows, viz.:

Coal	22.193 tons	
Ritchie mineral	696 "	
Oil	26 "	22.915 tons.
Gas made by station meter	251,688,000 cub. feet.	
=per ton	10,983 "	
Gas consumed. Consumers meters	239,987,533 "	
=per ton	10,473 "	
Gas unaccounted for	11,701,467 "	
=4 64-100 p. c.		

Our engineer would prefer wet meters, but owing to climate use dry entirely. In 1864 our loss was 13 per cent. We commenced and stopped every leak in street mains and service pipes, after which we established the most rigid scrutiny of our meters. A careful clerk compares every bill with with the preceding one for the same meter, and at the least irregularity the meter is taken out and tested, and if out of order repaired and put back. We believe the great source of loss to be at consumers' meters.

Our loss for several years has been as follows, viz.:

1871, 4 71-100 per cent		
1872, 8 84-100 "	}	Average, 6 86-100 p. c.
1873, 9 26-100 "		
1874, 4 64-100 "		

All our gas is sold by meter. We have 30 street lamp meters, and take the average of them.

Very truly yours, ——— Pres't.

Remarks by J. R. S.—This company, which we designate "A," lights about 3,500 lamps, and makes no allowance for difference in consumption between metered and non-metered lamps. The burners used on public lamps are lava tip six feet, with check inside.

As the metered lamps, from which the lamp-consumption is estimated, must burn less gas (on account of the delivering pressure being reduced by the amount required to drive the meters), it is evident that the whole of the lamps burn more than calculated; and that the leakage is really less than the figures reported, low as these are.

B.

Office of * * * * Gas-Light Co.,
October 8, 1875.

James R. Smedberg, Esq.

My dear Sir: I have no data of any kind in regard to the carbonizing accounts and leakage of any company except our own. I have often tried to obtain official figures from some of the large companies, but always without success. These are matters upon which the majority of our brethren prefer to make loose verbal statements instead of transcripts from the records. The latter leave no room far expansive fancy.

I shall, however, reply carefully and cheerfully to your questions as far as this company is concerned, giving you the results of the past three years, and shall be very glad to receive a copy of your report wheo completed.

1st. Gas sold per ton of coal carboniaed (2240 lbs).

In 1872, 10,653 cubic feet, C. P. 15.5 old London burner, "Bunsen Photometer."

In 1873- 10,704 cubic feet, C. P. 15.6, old London burner, "Bunsen Photometer."

In 1874, 10,926 cubic feet, C. P. 17.22, new London burner, "Bunsen Photometer."

The coal used during these years was Youghiogheny, pure and simple.

2nd. *Gas registered per Station Meter per ton.*

In 1872	11,050 cubic feet.
In 1873	11,050 "
In 1874	11,279 "

In addition to the gas *sold*, there was accounted for in each year (as gas used and given gratuitously) the following quantity per ton:

	1872.	1873.	1874.
Works, office and officers	94 c. f.	96 c. f.	10 c. f.
Charity Hospital	60 "	62 "	53 "
	154 "	158 "	154 "

The actual quantity lost, therefore, or unaccounted for, by leakage, condensation, etc., etc. was, per ton:

In 1872, 243 cub. ft.=43,138 cub. ft. per mile of main per annum.

In 1873, 188 cub ft.=32,035 cub. ft. per mile of main per annum.

In 1874, 199 cub. ft.=30,975 cub. ft. per mile of main per annum.

3rd. *The probable point of greatest loss.*

In our case, by far the greatest loss is from defective service pipe. I have seldom found any leakage in the joints of the mains, and we take pains to keep the meters properly supplied with water.

4th. *Meter.*

I prefer the wet meters, when the water line is attended to they are perfectly reliable. We have some Crossly meters which have been constantly in action from 25 to 30 years, and they are still at work in good candition. The dry meters require overhauling at least once in two or three years, and are not so durable eventually as the wet. We make it a rule to take in and test every dry meter we have once in two years, and seldom find them varying less than 5 per cent. sither way, and often 10 or 20 per cent., as frequently fast as slow.

5th. *Our plan for detecting street leaks* is peculiar. but answers the double purpose of exposing every bad joint and corroded service pipe, as well as cleansing the mains from all deposits or scale. Our mains are all laid under water, and any defect in a joint or rust hole in a service produces a flow of water into the main, accompanied by a deposit of earth, which would ultimately fill the pipe. This water must be pumped out at great expense from the drips, and compels us to be very particular about joints and service pipes.

When an increase in the normal pumping of a drip betrays undue leakage into the line of main draining into it, an investigation is made, as follows:

A given length (say 300 yards) of the main is isolated by cutting at each end, and at the intersections with other mains. The cut ends of the side openings are securely plugged, and all stop-cocks shut off at the meters on every service attached to the main under treatment. A piston, made of a cylinder of hard wood of smaller diameter than the main (but provided at front and rear ends with stout rubber discs fitting snugly the interior bore of the main) is then inserted in one end of the main, and a cast iron cap is secured to the pipe, closing this end.

To this cap is fixed a hose coupling to which is attached the hose of a steam fire engine. Water is than pumped into the main, the pressure of which drives the piston forward, carrying all sedimentary deposit and other obstructions before it, and proving all joints behind it. Wherever a defect of any kind, either in castings, joints, or corroded service pipe exist, the pressure of water discovers it, and a surface leak marks the spot. When the piston has reached the other end of the main it leaves the pipe as clean as a gun barrel, and every leak is found and repaired.

This operation is simple, certain, and not expensive. It need not be repeated on the same length of main oftener than once in fifteen years. The pressure of water required to force the piston through ranges (according to condition of pipes) from 50 lbs. per square inch for large mains (say 12 inch to 20 inch) to 100 lbs. for 3 inch to 4 inch. I have seldom found the ordinary lead joints, when well caulked, to leak under a pressure of 75 lbs. per inch.

I attribute our small loss of gas principally to this crucial testing of our mains and services, and to the fact that we have for many years been replacing all our *iron* service with *lead* pipes instead. These latter are practically indestructible, while the wrought iron tubing does not average more than seven years of life in our soil, which is strongly impregnated with potash.

I have written in a hurry: but should you wish any further details shall be glad to furnish them.

Sincerely yours, ———, Eng'r.

Remarks by J. R. S.—This company supplies about 3,600 lamps, none of which are metered. The average pressure in certain districts is carefully taken at stated periods, and the burners for each district are adjusted to consume the specified quantity par hour; under the average ascertained pressure of the district. The proving under water pressure by a traveling piston is a patented one.

As the *per centages* of loss are not expressed directly, I give them herewith:

1872	2 2-10 per cent.
1873	1 7-10 "
1874	1 8-10 "

The readers of the above letter from the "B" company will join me in regarding it as an exceedingly curious and valuable contribution to the literature of coal-gas. The street loss reported is probably lower than that of any company in the world; and the reputation of the author for exact investigation is such as would probably convince the most doubting Thomas of the truth of the figures given.

The use of lead services, as a substitute for the very perishable wrought iron tubing commonly employed, has long been advised by certain transatlantic brothers of ours; and is well worthy the consideration of all.

I will forward other letters by an early mail.

Respectfully,

James R. Smedberg.

Mr. Allen's Reply to Mr. Patton.

4 Warren St., N. Y., Dec. 8, 1875.

Mr. Editor: Mr. Patton is at liberty to call my exposure of his groundless assumptions an "attack" upon him, or to deal in any amount of slang which he deems wit, when he answers me. But when he presents himself in public as a teacher or adviser on the subject of gas manufacture, he ought to know something beyond mere "petroleum," and that it will

give light. He has the right to present and advocate any method of making gas which he thinks is the best. But let him hoist his true colors and not mouse around, and while hide-bound with "pure oil gas," pretend to be giving disinterested advice, and in a covert manner, condemn what he has never seen or investigated.

Mr. Patton has, for a long time, been gassing in the public papers about "dilutants" (pity that our Lexicographers are so ignorant as to spell it "diluents) and he has with as much self complacency as though he thought wisdom would die with him, pronounced "*any dilutant*" to be "a mere temporary subterfuge only," and now in your last issue he repeats the intolerable absurdity. "that gas which will not give any light is not worth any money for illuminating purposes."

Furthermore, he grossly misrepresents me, and unblushingly alleges that the substance of my statement is, "that worthlessness is value, and that any person who says it is not is untruthful"

Such a mode of answering an opponent merits a severe rebuke. Mr. Patton does not seem to be able to comprehend the fact, known to every man before he is half competent to give advice on gas manufacture, that the element in gas, which in itself has no light, and is, therefore, called *non-illuminant*, is of great value and actually indispensable, because it is the *inflammable* part of gas, and furnishes the *heat* without which there can be no light. Why does a pine knot, or an Esquimaux lamp, or "pure oil gas' smoke? Simply, because there is too much carbon present, while the non-illuminant, "that gas which will not give any light" but only heat, is deficient.

What man of any scientific knowledge or experience will contend that because guano is a rich fertilizer, therefore it should be used pure, sprinkled with the thumb and finger on the land; and that any dilution of it is a detriment, and "a mere temporary subterfuge only"? It would be as senseless as Mr. Patton's ideas about gas.

The mere fact that coal gas, so long and so extensively used, contains about *ninety-three* per cent. of such non-illuminant, or "that gas which will not give any light," utterly refutes Mr. Patton's preposterous theory. But then he condescends to tolerate this evil in coal gas, "as a tribute to established usage and invested capital," and because it is inseparable from its production."

A wonderful concession for a covert advocate of "pure oil gas" to make, not to the intelligence of the great fraternity of coal-gas manufacturers, but "*to established usage and invested capital*"! "A Daniel come to judgment"! Is it very flattering to those who persist in making gas from coal?

Now, I believe the true ground is simply this. All gas made from oils or rich coals *must be diluted* to make it merchantable. The question then arises—What is the best diluent?

I reply, that a permanent, incondensable, *non-illuminating gas*, of moderate specific gravity, and of the highest calorific intensity is, in my judgment, the best, because when made, it is not lost again by condensation, and it creates a heat which gives brilliancy to the minute atoms of carbon, constituting about *seven* per cent. of the whole, which have been added to such diluent, either from rich coals or oils. Then as to the commercial value, that diluent having the above qualities, which can be produced at the least cost, is preferable to all others.

And now, without dodging under any cover, or pretending to be giving any *disinterested advice*, or caring whether Mr. Patton calls it "greased wind or oiled water," or anything else he pleases (except a "pure oil gas" humbug), I openly avow that I am interested in what I advocate, and that I fully believe that "water gas," as made under our process possesses all of the above requisites of the best diluent, and that, with the proper per centage of the illuminating element added to it, either from rich coals or oils, the result is, the cheapest and most brilliant and permanent gas made in this country.

But Mr. Patton, in his usual course of dodging any discussion of the composition of water gas, and without having ever examined the results produced by us, intimates that we are attempting "to manufacture *imitation coal-gas*." Well, I will merely say, that if we are doing so, we have succeeded in making the *imitation* far superior to the *original*, and if any one doubts this, he can, by a visit to the city of Poughkeepsie, N. Y., where both kinds are produced, satisfy himself by a comparison.

About 60,000 feet a day of this "imitation gas" are used for lighting in that city, with the greatest satisfaction to the consumers. The professor of chemistry in Vassar College, in a note enclosing payment of his gas bill says, "Your gas yields a pure and brilliant light, in every respect unsurpassed." Are those who made the original, which we are charged with *attempting to imitate*, troubled often with such expressions from their consumers? And if they received them, would they think that a little cheap wit, or a sneer was a proper answer?

A short time since, a gas engineer from London spent two days at Poughkeepsie, examining the new works and our process, and the gas made, and having examined various other processes, including those for making oil gas, expressed his opinion that ours was superior, and came nearer to the results claimed than any he had seen. With all the merits, scientific and practical in our favor, I am content to let Mr. Patton praise his smoky idol, "pure oil gas," only advising him not to condemn what he has never investigated, and does not comprehend.

H. P. Allen.

Gas-Light Intelligence.

Great Britain.

Reduction in the Price of Gas.—The Phœnix Gas Co. have issued notices that the price of gas supplied by meter will be reduced to 3s. 6d. per 1000 feet, as from Christmas next, (that is, from the date of registering the index of each meter respectively). The Congleton Town Council have just reduced the price to 4s. 2d. per 1000.

Swansea Gas Works.—Messrs, Willey and Ford, gas engineers of Exeter, have just completed the erection of four new purifiers, each 20 feet square, with hydraulic lift and 18 inch centre valve, at the Swansea gas works, and which are working most satisfactorily. The same firm has also been favored with the contract for the erection of a new 60 feet telescope gasholder and cast iron tank, to be erected forthwith at the works of the Aberdare Gas Co.

Complaints of the quality of the gas supply are abundant at Leeds, but the corporation make no sign. The case is quoted as an instance in which a corporation in possession of a gas undertaking have failed most conspicuously in giving satisfaction to their constituents, and or no reason that we can appreciate. They bought up the companies at a cheap rate, and the borough is favorably circumstanced for a good and cheap supply of gas.

Gas shares continue in great demand, and accordingly rise in value. The reason, perhaps, is not far to seek. The collapse of many foreign securities (?) has caused a diversion in favor of sound home investments; and among these gas shares stand in the foremost rank. We need not conceal an opinion that a more popular appreciation of the value of gas property strengthens enormously the case of the companies.

The total amount of capital invested in the eight metropolitan gas companies is ten millions sterling.

The gross expenditures of the gas companies in the year 1874 amounted to £620,000, of which 55 per cent, or £470,000, was paid for new buildings and machinery; 20 per cent., or £122,600 for new and additional mains, and the remaining 5 per cent. for new and additional meters, fresh land, and law charges.

In mid-winter some of the largest gas works have to send out as much as 17,000,000 cubic feet of gas in the course of the night.

Some of the gasomoters are now 140 feet diameter and 70 feet high, and have a capacity of upwards of a million cubic feet.

The gross quantity of gas supplied to the entire metropolis now is as much as 14,000 millions of cubic feet per annum, which is at the rate of 38½ millions of cubic feet per diem.

To produce this enormous volume of gas about 1½ million tons of coal revuire to be carbonised, or "coked," in the course of the year.

Each ton of Newcastle coal produces on an average 10,000 cubic feet of gas and 1 cwt. of coal about 2½ bushels of coke.

The cost of the coal alone for lighting London with gas amounts to 1¾ million of money per annum.

The value of the "residual products," such as the coke, the breeze, the tar, and the ammonia liquor, arising from the destructive distillation of the 1½ million tons of coal, is as much as £700,000 per annum,

The "gas rental" of the entire metropolis is just upon three millions of pounds sterling, including rather more than a quarter of a million paid for the public lamps; so that not quite 2¾ millions are paid for the gas supplied "per meter."

The total length of the streets of "London according to Act of Parliament," is 2.500 miles.

The total length of the gas-mains throughout London is more probably 5,000 than 10,00 miles, as is generally supposed.

The total length of the Paris mains is only 960 miles- and those of Dublin 3,000.

The average eqpense of laying down these mains is about £770 per mile.

The cost of the repairs and renewals of the street-mains comes to £63,000, odd in the course of the year, which is at the rate of just upon £25 per mile.

The number of street lamps throughout London is 54,000 odd (instead of 360,000! as assumed by Mr. Barlow), or one lamp to about every eighty yards of roadway.

The gross cost of erecting the 54,000 street-lamps could not have been less than 135,000. The street lamgs consume just upon one thousand million cubic feet of gas per annum.

The gross cost of the gas consumed by the street-lamps is upwards of a quarter of a million pounds yearly. The entire street lamps of London consume as nearly as possible three millions of cubic feet of gas nightly, which represents an average of 300 tons of Newcastle coal carbonized per diem; and though the coal alone required to light the streets of London every night costs £375, the expense of the public lamps is less than the tenth of a farthing per night to each of the four million inhabitants.—*Journal of Gas Lighting.*

American Patents.

Important New Order of Commissioner of Patents.—The acting Commissioner of Patents has recently issued the following order:

United States Patent Office,
Washington, D. C., September 29, 1875.

Employees of the office have been strictly prohibited, under penalty of dismissal, from furnishing copies of official records except when ordered through the regular official channel. It is understood that the practice has grown up partly because of the difficulty in procuring copies by regular order when required for immediate use. That no such inconvenience may arise, orders for copies needed immediately will, upon special request, be made specially and filed at once.

Ellis Spear, Acting Commissioner.

Patents issued for week ending Nov. 16, 1875.

	Class.	Number.
Carburetter—S. McKissock, Allegheney, Pa.; filed July 15, 1875...	27	170,097
Gas Apparatus—J. H. Eichholz, Brooklyn, F. Y.; filed September 26, 1875.....	66	169,973
Gas Retort Lid—H. Collinson, Boston; filed October 13, 1875.....	66	169,960
Lantern and Dinner Kettle combined—W. W. Price, Petitcodiac, Canada; filed March 18, 1875.....	65	170,110
Electrical Water Raising Apparatus—Elias Ponvert, Jr., N. Y.; filed September 13, 1875.....	50	170,014
Steam Pump—James McCormick,		

☞ *For other reading matter see page* 230.

THE AMERICAN GAS-LIGHT JOURNAL AND CHEMICAL REPERTORY.

Publishing Office, No. 42 Pine Street.

PUBLISHED ON THE 2ND AND 16TH OF EACH MONTH

At No. 42 Pine Street, New York.

A. M. CALLENDER & CO.,

PROPRIETORS.

Editor—G. WARREN DRESSER.

This is a recognized official organ of—
LIGHT, HEAT, MINING INTERESTS, STEAM,
WATER-SUPPLY, PATENTED INVENTIONS,
VENTILATION, SANITARY IMPOVEMENT, AND
GENERAL CHEMICAL SCIENCE.

TERMS

SUBSCRIPTION—Three Dollars per annum, in advance.

AGENTS

NEW YORK—AMERICAN NEWS COMPANY, 119 and 121 Nassau St
BOSTON—S. M. PETTENGILL & Co., 6 State Street.
PHILADELPHIA—COE, WETHERILL & Co., Ledger Buildings, Phila.
Germany—B. WESTERMANN & Co., of New York.

☞ All communications to be addressed to **"The Proprietors,"** No. 42 Pine Street, Room 18, New York.

THURSDAY, DECEMBER 16, 1875.

WISHING TO MAKE THIS JOURNAL an organ of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, the publishers solicit letters from all among them who make the study of these subjects a pleasure, or a profession.

Subscribers would confer a favor upon us by remitting *CHECKS*, or *POST OFFICE MONEY ORDERS*, as we are frequent losers where money is enclosed in letters.

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15 AND 20 CANDLES.

The Senate Committee of Investigation continued its work yesterday at the Fifth Avenue Hotel:

W. A. W. Wilkinson was then examined in relation to the quality of gas supplied by the different city companies. He is Assistant Professor of Chemistry in the College of the City of New York; he has been employed in testing the gas made by the Mutual and Manhattan companies; that of the Manhattan averaged fifteen candle power; that of the Mutual about twenty candle power; the difference arises from the mode of making the gas; the Mutual works under a patent process, which involves the use of naphtha, a product of petroleum; the Manhattan uses coal only. The Mutual was the least expensive process; the witness had no interest in these patents, but was employed from day to day by the engineer of the Mutual to test the gas in order to prevent their product from attaining too much power, as the gas then would smoke.

We cut the above from the New York *Herald*, of December 11th. It seems to us that there must be either some misprint or some mistake in this statement. We understand that the object of the special "Senate Committee of investigation," is to collect facts with reference to any matters whereby the city treasury is defrauded, etc., etc.

Now, if the illuminating power of the gas furnished the city is as low as stated above, then the city fails to get what it contracts for by about six per cent. From the well-known character of the Comptroller of New York, it is not to be supposed that this would be allowed, and if a rumor of such a shortcoming on the part of any contractor were to reach him, he would doubtless at once refuse to pay the bills until satisfied that the contract was fulfilled according to the letter. It would certainly be a short-sighted policy for any gas company to lay themselves liable to such an extent, for while in the case of a private consumer they may be quite independent, and cut off the supply if the bills are not regularly paid; when it comes to the matter of the thousands of city lamps, it is another thing, for the city cannot be left in darkness in the first place, and, secondly, it would be no small undertaking to cut off all the city lamps. Aside from all this it would seem to the casual observer that the gas referred to was of more than 15 candle power, but in this any one may be mistaken, of course. The success which has thus far attended the Mutual Company, in furnishing gas of higher illuminating power than the others, may be due to the superior chemical advice which they receive from the College of the City of New York; but if so, many people have been laboring under a mistake, for there has been an impression that whatever of success the Mutual has obtained in the quality of their manufacture, has been due to the untiring and persevering efforts of their engineer who has probably had as much experience in making gas from naphtha on a large scale as any dozen men in the country. He has doubtless had difficulties to contend with in getting at the true way of manipulating the naphtha; and, if we are correctly informed, the process now used is different from anything covered by the patents owned by the company.

However great these difficulties may have been, the reason given at the close of the above extract for employing the chemical skilled talent of the College of the City of New York, does not seem a very good one. Does any one suppose that a man in the position, and having the experience of the engineer of the Mutual Company, cannot tell whether his gas will smoke or not without going outside of his works?

We hope at some not very distant day to be able to give our readers a full account of the manufacture of gas at the Mutual Company, and then they will be able to judge of it for themselves.

We have heard it rumored, and we wish it distinctly understood that we give it merely as a rumor, that the Chemical Department of the College of the City of New York has been in the habit of holding up to its students, as the "model works of America," the New York Mutual's.

Has the fact of being "*employed* from day to day" been the means of giving superior facilities for seeing the perfections of those works? And is it possible that there is nothing that would be worth while for students to know in any other process or in any other works. Teachers should above all things be impartial, and we can not but think that the above rumor must have been distorted; for if a teacher in a public institution should so make invidious comparisons, it would be at once questionable if he would not better serve the public interest, by yielding to others the duty of imparting true knowledge and devoting his talents exclusively to those who were willing to employ him from day to day.

HEAT UNITS—I.

We give the following extract from *Iron*, of Nov. 13; and we do so under the belief that when the question is—"what results can be obtained by the use of a given amount of fuel?"—the true basis of arriving at the comparative value of results is to be found in reducing the whole matter to a common basis or unit. We trust that our gas engineers may take hold of this matter, and see if a common standard may not be arrived at, so that when it is desired to get at the comparative cost, or value of different processes, all may have the same standard to start from. This will of course necessitate a careful division of the different items that enter into the manufacture of gas, so that the profit and loss of each item could be worked out by itself. The following article was translated from the Swedish, for *Iron*, and was written by Richard Akerman, Esq., of the Stockholm School of Mines.—It is a plain explanation of the subject of heat units, and we would ask for it a careful perusal. It was written more especially in connection with blast furnace operations, but it seems as though the same principles could be applied in analyzing the operations of gas works:

"One of the principal conditions for a proper carrying on of business is unquestionably a clear and perspicuous bookkeeping, which arranges all the separate payments and receipts under proper heads, and in consequence thereof shows distinctly the debit and credit of every account. If every department of the business has not its own account in the reckonings it is only possible to see from the balance how the whole and not how every separate part of the business has succeeded. In other words, there is thus no indication given of the alterations necessary for reaching a better result, because for this it is requisite that there be at least a possibility of ascertaining what departments of the business gave the smallest return, and which of the outlays were the least necessary.

We cannot, however, as everybody knows, arrive at any balance without the help of more or less tiresome figures, and this, unfortunately, is the case here too, on which account I will endeavor, as far as possible to state this "balance" so that those who are not interested in any examination of details may be able with the greatest possible ease to gather the cyphers arrived at, which are of the greatest importance in practice without being under the necessity of troubling themselves on this account with the deductive processes by which they are obtained; but, on the other hand, I consider myself also bound to

state the special calculations so fully that they may with the greatest ease be examined by those who are disposed to revise them.

As this paper is not intended solely for those who are at home in natural science, but, on the contrary, is written with a view to influence practice, it may perhaps be necessary in the first place to state the principal physical data on which the following calculations are founded.

Heat Units and Calorimetric Heating Effect.—It ought first to be stated that when one substance enters into a chemical combination with another it commonly takes place with a development of heat, and that the heat thus developed is called the "calorimetric heat" of the substance in question in relation to the other substance with which the combination takes place. For measuring this heat there are used so-called heat units, by a heat-unit being understood (in Sweden) the quantity of heat which is required to raise the temperature of one Swedish pound of water (0·937133 lb. avoirdupois), one degree of the Centigrade thermometer. Thus when it is said that calorimetric heating effect of burning to carbonic acid *one weight-unit of carbon* is 8080 heat-units, we understand hereby that when one weight-unit (1 lb.) of carbon is burned to carbonic acid, so much heat is developed that 1 lb. of water may thereby be heated 8080 deg., or, which is the same thing, that 8080 lb. of water may thereby be heated 1 deg. Cent. But when 1 lb. carbon is burned to carbonic acid it combines with 16 : 6=2·667 lb. oxygen, and we can speak both of the calorimetric heating effect of carbon *per weight-unit of itself and per weight-unit of oxygen*, understanding in the latter case, if we still keep in view its burning to carbonic acid, not as formerly the quantity of heat developed during the burning of 1 lb. carbon and 2·6667 lb. oxygen to carbonic acid, but the heat which is given off when 6 : 16=0·375 lb. carbon combines with 1 lb. oxygen to form carbonic acid. The calorimetric heating effect of carbon when burned to carbonic acid *per weight-unit of oxygen* is therefore 0·375 × 8080=3030 heat units.

One substance, however, as is well-known, may commonly enter into several different chemical combinations with another; and this is also the case with carbon, which may not only, as has been already mentioned, combine with oxygen to form carbonic acid, in which case one equivalent (six weight-units) of carbon takes up two equivalents (sixteen weight-units) of oxygen, but also to carbonic oxide, in which case one equivalent (six weight-units) of carbon combines with one equivalent (eight weight-units) of oxygen. For these different stages of oxidation the calorimetric heating effects of carbon per weight-unit of itself are quite different, its heating effect *when burned to carbonic acid* being, as has been stated, 8080 heat-units, while on the contrary, *when burned to carbonic oxide*, it is only 2473 heat-units. But in the same proportion as the heating effect of carbon when burned to carbonic oxide is low, is the calorimetric heating effect of carbonic acid when burned to carbonic acid, on the other hand, high, so that the same amount of heat is always developed, whether a certain weight of carbon is first burned to carbonic oxide and afterwards to carbonic acid, or the same quantity is directly oxidised to carbonic acid. Thus there are given off during the burning of 1 lb. carbon to carbonic oxide 2473 heat-units, whereby (6+8) : 6=2·3333 lb. carbonic oxide is formed, and its heating effect when burned to carbonic acid *per weight-unit of carbonic oxide* is 2403, there must be developed during the burning of the quantity of carbonic oxide in question, the considerable amount of 2·3333 × 2403=5607 heat-units, which, together with the 2473 heat-units generated during the burning to carbonic oxide, make 8080 heat-units, or as much as if 1 lb. carbon was directly burned to carbonic acid.

The calorimetric heating effects of different substances have in general been ascertained by direct experiment; but, on the other hand, it is received as an axiom that when a chemical combination of two substances is broken up, as much heat is consumed or rendered latent as is given out at their combining. If (6+16) : 6=3·6667 lb. carbonic acid is decomposed into 1 lb. carbon and 2·6667 lb. oxygen, 8080 heat-units must be taken up or rendered latent. From this and from the circumstance just stated that the same quantity of heat is developed, whether a certain quantity of carbon is burned at once to carbonic acid, or first to carbonic oxide, which is afterwards oxidised to carbonic acid, it follows quite clearly that if 1 lb. carbon is first burned to carbonic acid, which, through contact with red-hot carbon, is afterwards reduced to carbonic oxide, whereby 1 lb. carbon in addition is consumed ($CO_2+C=2CO$), the difference between the heat which is hereby developed and consumed must be equal to the quantity of heat which would arise from the burning of 2 lbs. of carbon at the same to carbonic oxide.

EXCURSIONS.

In the Richmond *Despatch*, of December 4, appears a long list of names, comprising the leading men in almost every prominent gas company in the Eastern States, who, it states, were expected to arrive in that city on that day. Now, we do not doubt but that a most hearty welcome would have been given every one of them, had they all arrived, and that those that did arrive were shown every attention and courtesy, both there and elsewhere. We deem it no more than just to say that many names on the list were not there. That they were invited to join an excursion to the coal regions is doubtless true; but why herald the arrival of men who never started from home? Why not give the list exactly as it was? Certainly, the names of those who did go were sufficient to give the utmost respectability to the party. Why, then, intimate that others were there, when some of those others were at home attending to the arduous duties of their various positions, and others confined to their beds by illness? No doubt it is a beneficial thing for gas managers to go and visit the different coal properties whose products they are liable to be called upon to use. But, is a party starting out under the guidance of any one interest likely to get the most perfect knowledge of all the coal fields, and to be able to compare the different mines and their products as thoroughly and satisfactorily as if a few engineers, say two or three, started out together on their own hook, and quietly visited all the different properties, or those that they were most likely to be called upon to give an opinion about, and to use, perhaps, in their own works. Far be it from us to detract from the benefits to be derived from travel; and we would unhesitatingly advocate more liberality on the part of gas companies towards their engineers, superintendents, etc., in the way of enabling them to go and study the coal regions thoroughly. It would undoubtedly pay most companies to send out their officers in this way, not at the private expense of the officers, but at the companies' expense, and thus be able to get reliable information direct from headquarters. But is not the matter of excursions objectionable when conducted in any other way than this? Let the party in whose interest the officer travels pay the expense; then all ground for criticism is at once removed, and the information gained and judgment formed cannot be charged with being biased by anything.

We understand that the excursion referred to was managed somewhat on this plan—that is, each one was expected pay his personal expenses, excepting "car fare"; but would it not have been better if even the latter item had been left for members to pay, each for himself. Why pay for a man's railroad tickets any more than for his board? We know that advertising pays, and coal men understand that as well as any one. But it is a question whether it is not better to let the coal men do their own advertising, than for Presidents, Directors, Superintendents, etc., of gas companies to do it for them. If it is a good time that is wanted, why have it by all means, but call it a good time; and when the representatives of a great interest, like the gas interest, go abroad to get information, and post themselves in important matters connected with their official relations and responsibilities, would it not be far better if they went under the direction and at the expense of the companies they represent, and in whose interest solely they are bound to act? The courtesy and liberality of the coal companies' officers is well-known, and there is probably not one of them who would not be very desirous of giving the fullest information about his own mines, if visited in the way suggested; and in this way the gas companies would become possessed of much fuller and more general information, as to the various sources of supply, than they would if their representatives had their attention directed solely to one property. It is very true that gas men stay at home too much, and this arises naturally from the duties of a practical gas manager. What is wanted is a more extended range of observation, and a fuller interchange of ideas and experience, and the companies themselves should enable their officers to have it.

TO OUR PATRONS.

With this number we close the XXIII volume of the AMERICAN GAS-LIGHT JOURNAL. Of its success in the past we must ask our readers to be impartial judges. Of the future we would speak with extreme diffidence; but we trust that there may be nothing to complain of which honest effort on our part can prevent. We begin our next volume with an additional number of pages, in order to give more reading matter, and meet the demands of our advertisers. We would again urge upon those engaged in the manufacture of gas, to avail themselves of our columns in imparting information upon points of interest, and in asking for the same when difficulties present themselves. We wish the gas people to feel that the Journal is *their paper*, and devoted to their interest first and foremost. Wishing our patrons each and all a Merry Christmas, and a Happy New Year, suggesting that subscriptions are now due, we remain, respectfully, G. W. D.

CENTENNIAL DRAWINGS.

Prospective or Geometrical Drawings

of Buildings and Apparatus, suitable for Exhibition Purposes. Finest work. Address

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126 East 52nd Street, N. Y.

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MANUFACTURERS OF

Clay Gas Retorts, Retort Settings, Fire Bricks, Etc.

Works, Lockport, Westmoreland Co., Pa.)
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Gen'l Agent for New England,
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IMPORTANT TO PLUMBERS AND GASFITTERS.

A CHRISTMAS PRESENT that will pay you to make. Expend one dollar and save hundreds.

PLUMBERS and GAS FITTERS GUIDE.

A book of Instruction with valuable Tables and Receipts; a Hand Book of Reference in making up Estimates. You should place it in the hands of all your employees.

Paper covers 75 cents; bound in cloth for Library $1.00 by mail, free.

396-2t J. D. GALLOWAY, No. 345 North 10th St., Phil'a, Pa.

Greenfield, Ohio, and S. R. Kelly, Baltimore, Md.; filed September 18, 1875.....	118	170,008

Patents issued for week ending Nov. 23d, 1875.

Gas Burner—A. M. Silber, London; filed October 19, 1875.....	64	170,407
Automatic Feed and Absorption Carburetter—S. Austin, N. Y. (reissue); filed November 13, 1875...	27	6,745
Chandelier—F. S. Shirley, New Bedford, Mass.; filed July 24, 1875...	64	170,194
Hydrocarbon Furnace—H. M. Smith Chicago, Ill.; filed April 1, 1875.	149	170,198
Process for Preventing or Removing Naphthalin Deposits in Gas Conduits—J. C. Tiffany, Coxsackie, N. Y.; filed Nov, 19, 1875....	66	170,414
Electric Gas-Lighting—E. E. Bean, Boston. Mass.; filed October 15, 1875. Arranges gas-lighting circuits so that they may be used as alarm telegraphs.....	64	170,221
Photometer—P. Munzinger, Philadelphia, Pa.; filed July 6, 1875...	157	170,292
Water Pipe—W. H. Lampson, Chicago, Ill.; filed July 15, 1875.....	167	170,305
Rotary Force Pump—A. Carlin; filed June 10, 1875.....	118	170,343
Ventilating Churches, Houses,, etc., W. Kingham, N. Y.; filed June 30, 1875.....	166	170,174

Gas Stocks.

Quotations by W. B. Scott & Co., Bankers,

24 PINE STREET, NEW YORK CITY.

DECEMBER 16, 1875.

☞ All communications will receive particular attention

Gas. Co.'s of N. Y. City.

	Capital.	*Par.*	*Bid.*	*Asked.*
Harlem.....	$1,850,000	50	139	140
Manhattan.....	4,000,000	50	209	212
Metropolitan.....	2,500,000	100	155	157
" Scrip...		..	103	105
Mutual.....	5,000,000	100	109	110
New York.....	4,000,000	100	149	150
Westchester.....	466,000	50	100	105
Gas Co.'s of Brooklyn.				
Brooklyn.....	2,000,000	25	245	...
Citizens.....	1,200,000	20	153	156
" Scrip.....		...	101	...
Peoples.....	1,000,000	10	99	100
" Bonds.....		...	96	98
" Scrip.....		...	95	98
Metropolitan.....	1,000,000	100	103	105
Nassau.....	1,000,000	25	128	135
Williamsburgh.....	1,000,000	50	150	155
" Scrip		...	100	102
Out of Town Gas Companies.				
Buffalo Mutual, N. Y	750,000	100	50	50
Baltimore, Md.....	2,000,000	100	190	...
Brockport, N. Y.....	25,000	...	...	85
Citizens, Newark....	500,000	...	...	55
Darby of Conn.....	160,000	100	...	80
East Boston, Mass..		25	112	115
Hannibal, Mo.....	100,000	100	58	60
Hartford, Conn.....	700,000	25	41	43
Hempstead, L	40,000	100	...	100
Jersey City	386,000	...	160	...
Jamaica, L. I.....	25,000	100	...	100
Jacksonville, Ill.....	120,000	50	80	90
Lewistown, Maine...	400,000	100	...	75
Lima, Ohio.....	60,000	100	10	...
Laclede, Mo.....			...	123
Peoples, Jersey City		...	130	...
Peoples of Albany...	1,000,000	100	...	60
Peoples of Baltimore		25	108	...
Rochester, N. Y.....		100	50	...
Richmond Co., S. I.	300,000	...	100	105
Fort Wayne, Ind.....		100	...	105
Woonsocket, R. I....	150,000	100	100	...
Halifax N. S.....	400,000	40	148	150
Hamilton, Ontario...	150,000	40	112½	

The growing use of kerosene in Brooklyn, resulting from the increase of 70 per cent. on bills to their consumers by the gas companies, compared with the same month of last year, causes a return of 1000 metres per month. This naturally has a depressing effect on gas stocks generally.

Sales of gas stock at auction since our last issue are 5 shares of Metropolitan Gas Company, N. Y., @ 157; 200 Metropolitan Gas Co.'s Scrip, @ 104½; 126 shares New York Gas Co., @ 147 @ 152½; also 314 shares of Manhattan Gas Co., at 309½ @ 311

PRICES OF FOREIGN AND DOMESTIC GAS COALS.

[Reported Expressly for this Journal.]

DECEMBER 2, 1875.

DELIVERED IN NEW YORK.

English Cannel.

Ince Hall	$17 00	@	18 00
Kirkless Hall	16 50	@	17 00

English Caking Coals.

Newcastle Gas	$5 75	@	00 00
Liverpool caking	11 50	@	12 00

British Province Coals.

Pictou			2 25
Rock House—At Mines, $1.87, Gold			0 00
Caledonia—At Mines, $1.75, Gold			0 00
Little Glace Bay—At Mines, $1.75, Gold			2 00
Lingan—At Mines, $1.75, Gold			0 00
Sydney—Old Mine			3 00
" Reserve, $1.75, Gold Mine			2 25
" International			— —

Duty, 75 cents per ton, gold. Freight to New York $2 25 (urrency. Cost of above coals delivered in New York, $5 25 @ $6 00½, currency.)

Pennsylvania Coals.

Penn Gas Coal—At Amboy	$6 10	@	0 00
Westmoreland—At Amboy	6 10	@	0 00

(In New York both the above coals $6 50)

Shafton	6 50	@	0 00
Youghiogheny	6 50	@	0 00
Waverly	6 50	@	0 00

West Virginia Coals.

Murphy Run	$6 50	@	0 00
Despard	6 50	@	0 00
West Fairmont	6 50	@	0 00
American Gas Coal	7 40	@	0 00
Fairmont	6 50	@	0 00
Newburgh Orrel	6 50	@	0 00
Pinnickinick	6 50	@	0 00
Cloverhill of Virginia	6 00	@	6 50
McKenzie Compound Mixture			— —

American Cannel Coals.

Peytona of West Virginia	$12 50	@	00 00
Darlington of Pennsylvania			— —
Cannelton Cannel			11 00
Red Bank—at Philadelphia			6 50
" —at South Amboy			7 25

Asphalts.

Albertite of New Brunswick	$— 00	@	— 00
Ritchie Mineral of West Virginia	18 00	at Balt'e.	
Trinidad Bitumen	— —	@	14 05

The Penn Gas Coal Company have contracted with the Pittsburgh Gas-Light Co. for their entire supply for the ensuing year from their Youghiogheny mines.

TO GAS COMPANIES, AND CITY GOVERNMENTS.

DYOTT'S PATENT CHAMPION STREET LAMP

Doubles the Light with the same quantity of Gas used in other Lanterns. *All others* waste half their light, illuminating the sky, or if the top s of metal, absorb it.

SINGLE TOP GLASS LAMPS BOTH GLOBULAR AND SQUARE become heated if a good light is put in them, and rain, hail or snow falling upon the HEATED GLASS BREAKS IT. When one glass is broken the wind will either blow the flame against the others and break them, or destroy the entire Lamp. *Nine-tenths of the breakage and cost of repairs of other* street lamps is owing to that cause.

DYOTT'S "CHAMPION" is the only DOUBLE TOP—the only Lamp that has the Opaline White Dome, which is a *never changing reflector;* it doubles the power of, and throws the light to a greater distance. It is also a perfect *protector*, shielding the heated top or the lamp from all inclemency of the weather. The white dome is kept cool by the passage of air between it and the transparent globe below. Rain, hail or snow will never break either the globe or dome. The globe rests upon rubber cushions, and is supported laterally by elastic springs, so that contraction or expansion of the globe, or jarring of the post will not break it. They can be cleaned in one-fourth the time required to clean other lanterns. The metallic portions are of iron, copper and brass, and are the most durable, economical, efficient and cheapest lamps in existence. For public buildings, and wherever an ornamental and powerful light is required, they are made in CLUSTERS of 2, 3, 4, 6, 7 and 10 lamps, which have no equal in this or any other country for *beauty, durability, efficiency* and economy, either in cost, use or ornamentation. Designs furnished when requested for specific purposes. Gas companies, or those who have the lighting of Cities in charge, are solicited to communicate with us in reference to the agency for its introduction.

The Franklin Institute has awarded our CHAMPION LAMP the highest premium: (they give a silver medal) and its Committee on Science and the Arts has recommended it as the best lamp in use. It has also invariably taken the highest premium at every Exhibition at which it has been presented, and elicits the strongest commendations wherever it is used. We have several new and handsome patterns of POSTS for Corporations, Parks, public and private use, also for clusters of lamps, that are not excelled in beauty or price at which they are furnished.

DYOTT MANUFACTURING CO.,
374-6meot 114 South 2nd Street, Phil'a, Pa.

Advertisers Index.

☞ In looking for advertisements, see figures 1 to 12, within brackets, at head of advertisement pages.

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Gasholders, Etc.—Deily & Fowler, 39 Laurel st., Phila., Pa.. 4
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Patent Gas Exhauster—Smith & Sayre, 95 Liberty stireet.. 4
Pelouze & Audouin Condenser—Jas. R. Smedberg, Sole Agent for U. S. San Francisco, Cal.; Henry Cartwright, 2107 Green street, Phil. Pa..... 1
Petroleum Gas—J. D. Patton, Trevertop, Pa..... 4
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GAS COALS

Cannelton Coal Co. of West Virginia—J. Tatnall Lea, 325. Chestnut street, Phila, Pa..... 3
Despard Coal Co.—Parmelee & Bros., Agents, 32 Pine st., New York..... 7
Gas Coals—Perkins & Job, 27 South st., N. Y..... 7
New York and Cleveland Gas Coal Company—384 Penn Avenue, Pittsburgh, Pa..... 6
Penn Gas Coal Co.—11 Merchants' Exchange, Phil. and 90 Wall street, N. Y..... 6
Peytona Cannel Coal—S. E. Low, 58 Broadway, N. Y..... 5
The Newburg Orrel Coal Co.—Chas. W. Hays, Agent in New York, Trinity Building, 111 B'way, Room 7..... 6
Tyrconnell Gas Coal—52 S. Gay Street, Baltimore, Md..... 6
Westmoreland Coal Co.—230 South 3rd Street, Phil. Pa.. 6
Youghegheny Coal—Perkins & Job, 27 South St. N. Y.... 7

FOUNDRIES.

Atlantic Dock Iron Works—John P. Kennedy, Office 98 Liberty street, N. Y., P. O. Box 2348.....
Cast-Iron Pipes and Fittings—B. S. Benson, 52 East Monument street, Baltimore, Md.....
Continental Works—T. F. Rowland, Greenpoint.....
Camden Iron Works, Camden, N. J.—Jesse W. Starr & Son.
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National Foundry and Pipe Works—Wm. Smith, Carroll, Pike, Smalliman & Wilkins streets, Pittsburg, Pa.....
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Pascal Iron Works—Morris, Taskar & Co., Philadelphia.... 12
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WATER METERS, PUMPS, ETC.

Cast Iron Pipes for Water and Gas—Riley A. Brick, 112 Leonard street, N. Y..... 10
Valves for Water, Steam and Gas—Ludlow Valve Man'g Co., 940 River street, Troy, N. Y..... 6

CLAY RETORT WORKS.

B. Kreischer & Son, Clay Retorts, etc., 58 Goerck st., N. Y. 8
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Manhattan Clay Retort Works, 15th st., near Av. C, N. Y.. 8
Philadelphia Fire Brick Works, Vine and 23d sts., Phila.... 8

LAMPS, STOVES, PETROLEUM, ETC.

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Analysis and Testing of Gas Coals—Prof. Henry Wurtz, 12 Hudson Torrace, Hoboken, N. J. 10
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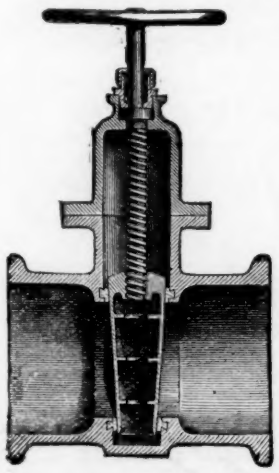
National Coal Gas Company—H. P. Allen, 4 Warren street New York..... 6
School of Mines, Columbia College, East 49th st..... 9
Screening Shovels—Herring & Floyd, 740 Greenwich st., New York..... 7
Scientific and Practical Chemist and Geologist—Profetsor Henry Wurtz, 12 Hudson Terrace, N. J.....
Screening Shovels—G. W. Dean, 1368 Broadway, N. Y.....10

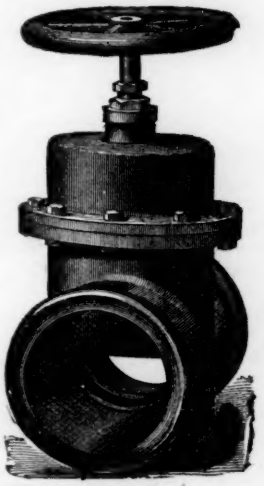
CHAPMAN VALVE MANUFACTURING CO.

MANUFACTURERS OF

CHAPMAN GAS VALVES.

Office and Sales Room 75 and 77 Kilby Street, Boston.





These Valves have been in use for several years, and are pronounced by all who have used them to be

The Best Gas Valves Ever Made.

They afford a direct passage the full size of the pipe. The seats are made of an alloy similar to BABBITT metal, specially prepared for the purpose, and superior to all other metals used for the seats of Gas Valves. It does not corrode under any circumstances to which it is exposed.

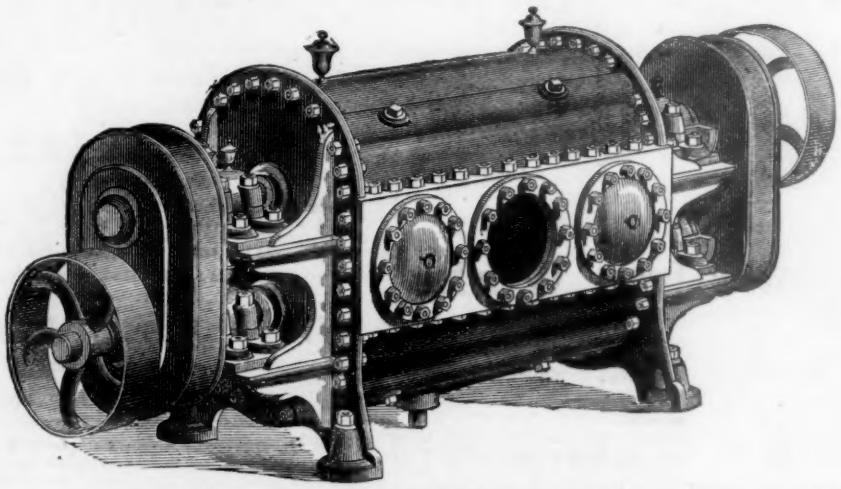
There is no LIABILITY OF COHESION between the Gate and Seat, and the Valves can be relied upon to SHUT TIGHT and OPEN EASILY at all times—an important desideratum when used for street mains, in cases of fire.

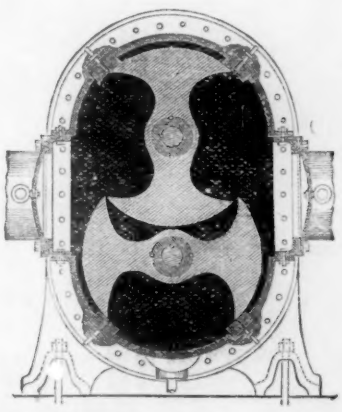
We refer to the following named Gas-Light Companies among the many that have used these Valves:

BOSTON GAS-LIGHT COMPANY, BOSTON, MASS.
CAMBRIDGE GAS-LIGHT COMPANY, CAMBRIDGE, MASS.
NEWTON & WATERTOWN GAS-LIGHT CO., WATERTOWN, MASS.
LAWRENCE GAS-LIGHT COMPANY, LAWRENCE, MASS.
PEOPLES GAS-LIGHT COMPANY, BROOKLYN, N. Y.
CITIZENS GAS-LIGHT COMPANY, BROOKLYN, N. Y.
SOUTH BOSTON GAS-LIGHT COMPANY, BOSTON, MASS.
CHARLESTOWN GAS-LIGHT CO., CHARLESTOWN, MASS.
LYNN GAS-LIGHT COMPANY, LYNN, MASS.
FITCHBURG GAS-LIGHT COMPANY, FITCHBURG, MASS.
CITIZENS GAS-LIGHT COMPANY, NEWARK, N. J.
WILLIAMSBURGH GAS-LIGHT CO., WIRLIAMSBURGH, N. Y.

GAS AND WATER VALVES ½ INCH TO 36 INCHES DIAMETER.
STEAM VALVES ½ INCH TO 12 INCHES DIAMETER.
357-tf

PATENT IMPROVED GAS EXHAUSTER.





P. H. & F. M. ROOTS, PATENTEES AND MANUFACTURERS, CONNERSVILLE, IND.
S. S. TOWNSEND, GENERAL AGENT, 31 LIBERTY STREET, NEW YORK.

The following are some of the advantages we claim for this Exhauster over all others:

FIRST.—It is simpler in its mechanical construction than any other Exhauster in use.

SECOND.—The internal parts consist of only two revolvers, each cast entire in one piece, without a single screw, bolt, nut, washer, key or other part to get loose on the inside and stop or break the machine. The internal operating parts, therefore, can not get out order, and hence require no care or attention.

THIRD.—Every part of the machine requiring care or attention, as the journals, gearing, etc., is external, easily observed and attended to. All changes, adjustments, and repairs are made from the outside. The journal bearings, if necessary, can be renewed in a few minutes.

FOURTH.—The internal operating parts are practically gas-tight, but are not in actual contact, hence there is no internal friction or wear. The machine is therefore operated with less power than any other.

FIFTH.—They are built in the most complete and substantial manner, with steel shafts and improved journal bearings, and their durability is almost without limit.

We build them of any required capacity, large or small, adapted to any kind of works or place.

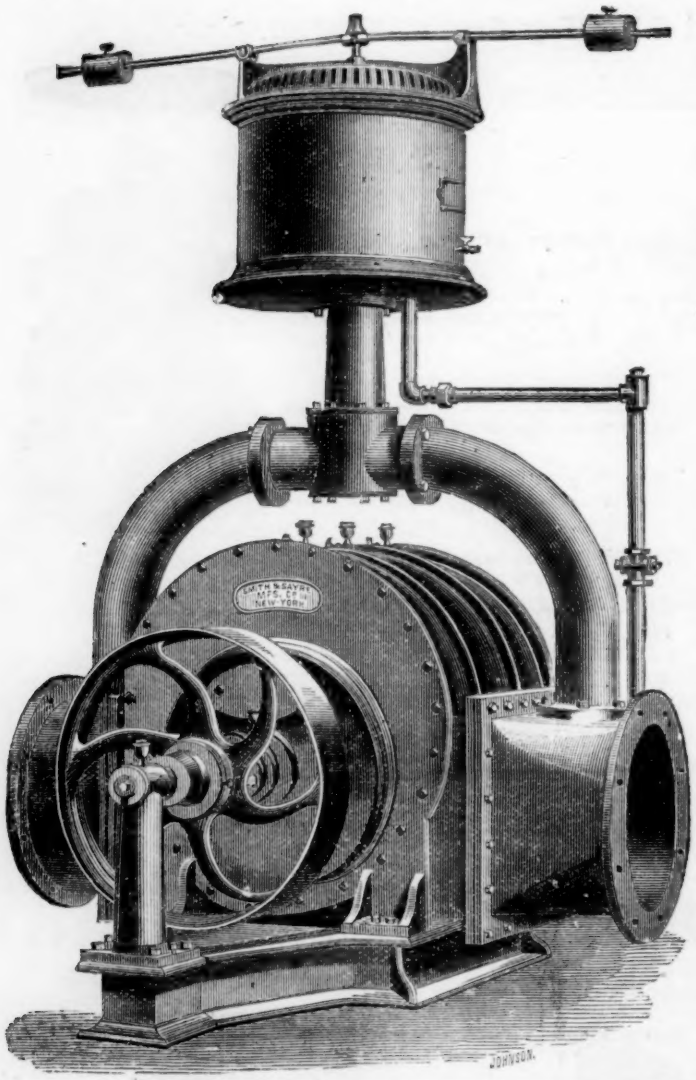
Send for Illustrated Catalogue, giving all particulars as to capacity, speed, power required, dimensions, and price of each size and references to parties using them.

P. H. & F. M. ROOTS,

SMITH & SAYRE MANUFACTURING COMPANY.

The Mackenzie Patent Gas Exhauster

And Patent Compensator.



They are made to pass from 4,000 to 150,000 cubic feet of gas per hour; will increase the production and illuminating power of the gas, and add very much to the durability of the retorts, either clay or iron. The Compensator obviates entirely the necessity of water-jo ints, is compact, durable, cleanly, not liable to get out of order, self-acting, quiet, and certain in its operation.

We are also sole proprietors and manufacturers of the

MACKENZIE PATENT BLOWER, PATENT CUPOLA AND SMELTING FURNACE.

The Blower is a Force Blast machine, durably built, and can be driven with one-third the power required to drive the ordinary fan.

The Cupolas are manufactured in sizes to melt from 1 to 30 tons per hour, will save one quarter of the time required by the old style Cupola and 33 per cent fuel. Address

G. G. PORTER, President.

JAMES M. SAYRE, Treasurer.

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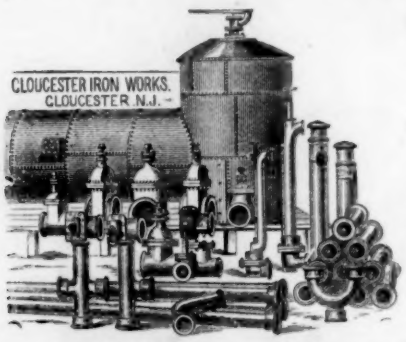

Gloucester Iron Works,

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BENJAMIN CHEW, Treas. WILLIAM SEXTON, Sup't.

CAST IRON GAS AND WATER PIPE.

Cast Iron Heating and Steam Pipe. Stop Valves, water or Gas.

Fire Hydrants,

GAS HOLDERS.

EVENS & HOWARD,

Manufacturers of a superior quality of

Fire-Brick, Clay Gas Retorts,

Gas Tile, Drain Pipe, Fine Ground Fire Clay, &c.

916 Market Street, St. Louis, Mo.

TYRCONNELL GAS COAL.,

MINED IN TAYLOR COUNTY, WEST VA.

Company's Office, 52 S. Gay St., Baltimore.

CHARLES MACKALL, Secretary.

CHARLES W. HAYS, Agent, Room 7, 111 B'way, N. Y.

SHIPPING POINT—Baltimore, Md.

This coal yields 10,000 cubic feet of Gas, with an illuminating power of over 15 candles. Forty bushels very superio Coke, with little Ash, and scarcely any clinker. 6d-1y

T. F. ROWLAND,

Continental Works,

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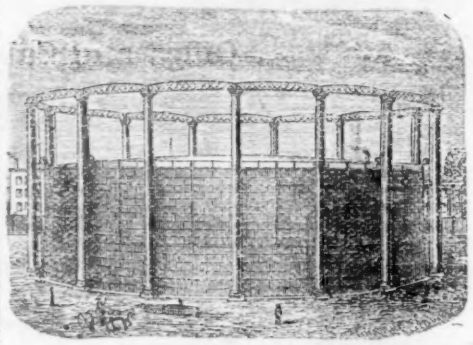

GAS-HOLDERS

OF ANY MAGNITUDE,

Condensers, Scrubbers, Purifiers, Retorts, Hydraulic Mains and all other articles connected with the Manufacture and Distribution of Gas, furnished with despatch. Plans and Specifications prepared, and Proposals given for the necessary Plans for Lighting Cities, Towns, Mansions, and Manufactories.

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Office in Philadelphia No. 435 Chestnut St., where a member of the Firm can be seen between 12 m. and 2 p. m. daily.

MANUFACTURERS OF

ALL KINDS OF CASTINGS AND APPARATUS FOR GAS WORKS,

Wrought Iron Roof Frames,

For Retort and other houses Retorts and all castings required for setting them in the latest and most improved model. WASHERS, CONDENSERS, SCRUBBERS and EXHAUSTERS for relieving the Retorts from pressure. PURIFIERS, varying from 2,000 to 2,000,000 cubic feet daily purifying capacity.

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for Purifiers. Station Meters of all sizes.

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With cast iron guide and suspension frames. GAS GOVERNORS or REGULATORS, STREET MAINS, from 1½ to 48 INCHES DIAMETER, for WATER or GAS. Street Main connections, such as BRANCHES, BENDS, DRIPS, SLEEVES, etc.

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All the Smith and Sheet Iron work required in and abou Gas Works. 226-tf

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Builders of Gas Works.

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Single and Telescopic.

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CONNECTED WITH GAS WORKS.

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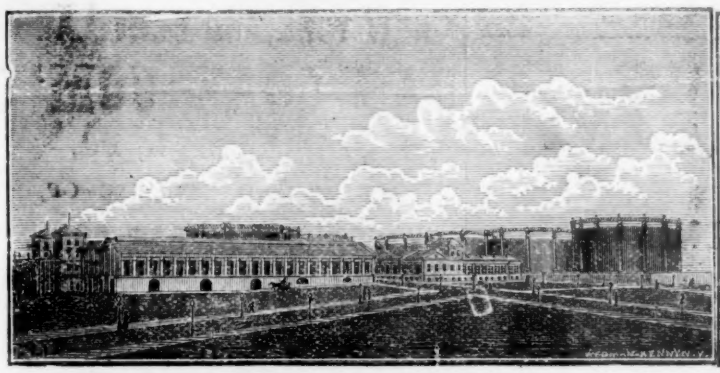
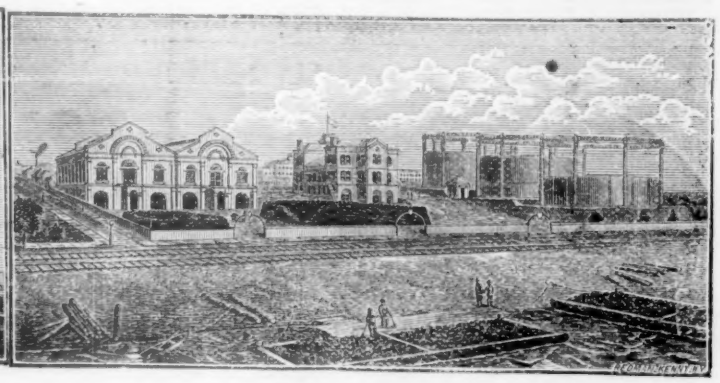


CINCINNATI GAS WORKS. ERECTED 1871-72-73.—WM FARMER, ENG.



LACLEDE GAS WORKS, ERECTED 1872.—WM. FARMER, ENG

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ARCHITECT AND GENERAL GAS ENGINEER,

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Exhausters for Gas and Foul Lime Ventilation,
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Professor SILLIMAN, New Haven, Conn.
GEN. CHAS. ROOME, President Manhattan Gas-Light Company, N. Y.
A. W. BENSON, President Brooklyn Gas-Light Company, Brooklyn, N. Y.
W. W. SCARBOROUGH, President Cincinnati Gas-Light Company, Cincinnati, Ohio.
S. L. HUSTED, President Laclede Gas-Light Company, St. Louis, Mo.
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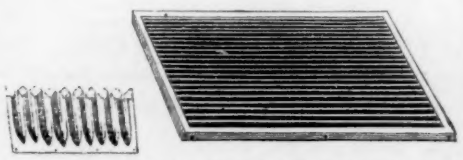

The above Trays are made from half inch to one and a quarter inch thick with a strong centre piece, bars bevelled on top. Also the Diamond Bar Tray can be used either side up; smoothest and most durable Trays in use. They are now used by more than three hundred Gas Companie in the United States and other places.

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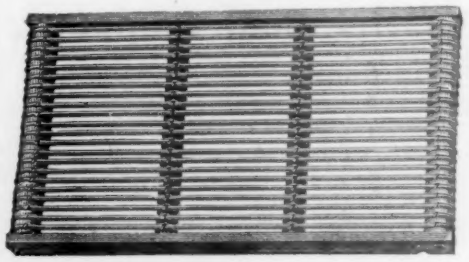
LIME HURDLES

after a practical trial have been adopted by over thirty Gas-Light Companies *the last season*, some of them the largest in the country.

They are LIGHT, STRONG and DURABLE, made *with Ash frame* and *round flexible Rattans.*



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WANTED—A SITUATION AS FOREMAN OR SUPERINTENDENT in Gas Works, or Meter Inspector, being practical in all branches of the business, a well as Meter maker. The last few years have been Superintendent and Secretary of a city of six thousand inhabitants.

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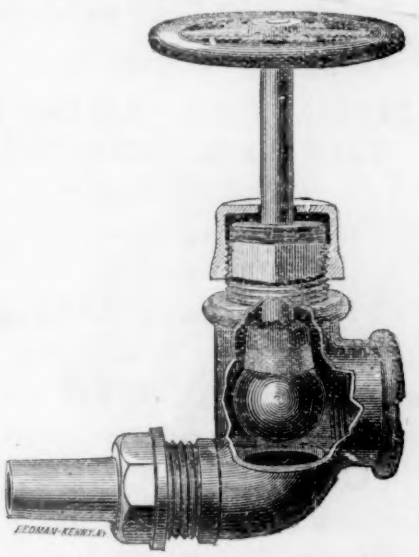
SOMETHING NEW.

THE HUMPHREYS VALVE.

FOR USE AT CONSUMER'S METERS.



This valve is made of malleable iron, and is specially adapted to encounter the heat of burning buildings, in which the ordinary meter cock (made of brass) will crumble or melt. It is opened or shut with ease, by sliding the stem up or down, the latter being held where desired by the friction of the packing. It is perfectly tight, and is not so liable to get out of order as the meter cock: its cost being about the same.

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THE
PENN GAS COAL COMPANY

OFFER THEIR

COAL, CAREFULLY SCREENED,

AND PREPARED FOR

GAS PURPOSES.

Their Property is located in the Youghiogheny Coal Basin, near Irwin's and Penn Station, on the Pennsylvania Railroad, and on the Youghiogheny River.

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OF WEST VIRGINIA.

Offer for sale the following Coals, from their Colliery at CANNELTON, Kanawha County, West Virginia, delivered at RICHMOND, Va.:

CANNELTON CANNEL,

cknowledged to be the most valuable ENRICHER produced in this country, a gross ton yielding **10,000** ubic feet of GAS of **64·54** CANDLE POWER; COKE **32** bushels, of good quality.

CANNELTON CAKING COAL.

Volatile Matter.	Coke.	Per cent. of Ash in		Sulphur in			Specif. Gravity.	
		Coal.	Coke.	Coke.	Ootl.	Volatile Matter.	Coal.	Gas.
35.1	64.9	2	6	.82	1.48	.66	1,289	.476

MAXIMUM YIELD, **5.06** cubic feet of Gas per pound of Coal—A yield of **4·78** cubic feet per lb.. —gave **16 14-100** Candle-Power.

COKE, of very fine quality—**1453** pounds produced from one ton of coal.

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ESTABLISHED 1840.

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Analyses and Prices of all the principal SCOTCH CANNEL COALS will be forwarded on plication. 329-1y

THE NEWBURGH
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SINCLAIR & AGNEW, Agents, Alexandria, Va.

This Company offer their very superior Gas Coal at lowest market prices.

It yields 10,996 cubic feet of gas to the ton of 2,240 lbs. of good illuminating power, and of remarkable purity; one bushel of lime purifying 6,792 cubic feet, with a large amount of coke of good quality.

It has been for many years very extensively used by various Gas Companies in the United States, and we beg to refer to the Manhattan, Metropolitan, and New York Gas Light Companies of New York; the Brooklyn and Citizen's Gas Light Companies of Brooklyn, N. Y; the Baltimore Gas Light Company of Baltimore, Md., and the Providence Gas Light Company, Providence, R. I.

The best dry coals shipped, and the promptest attention given to orders. 294-1y

THE DESPARD COAL COMPANY

OFFER THEIR SUPERIOR

DESPARD COAL

To Gas Light Companies throughout the country.

Agents, PARMELEE BROTHERS, No. 32 Pine street, N. Y.
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Mines in Harrison County, West Virginia.
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Among the consumers of Despard Coal, we name: Manhattan Gas Light Company, New York; Metropolitan Gas Light Company, New York; Jersey City Gas Light Company, N. J.; Washington Gas Light Company; Portland Gas Light Company, Maine.

*** Reference to them is requested. 204-1y

NEW YORK AND CLEVELAND
GAS COAL COM'Y
Of Pittsburgh, Pa.

MINERS AND SHIPPERS OF

YOUGHIOGHENY GAS COAL.

This Company is prepared to furnish any amount of their justly celebrated, and acknowledged superior GAS COAL, to any point reached by railroad or navigation, on most favorable terms.

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WILLIAM A. McINTOSH, President.
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PEYTONA
CANNEL COAL
From West Virginia.

Yields over **13,000** feet of Gas per ton. At ten thousand feet (standard yield) the illuminating power is over **43** candles. Purifies **4,510** feet to the bushel of lime.

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No. 4 Warren Street, New York.

H. P. ALLEN, President.
I. B. BRICE, Vice-President.
A. H. ALLEN, Secretary.
WM. J. VALENTINE, Treasurer.
GEORGE W. HARRIS. Engineer.

This Company is the owner of the GWYNNE-HARRIS, o AMERICAN HYDROCARBON process, for making Gas for Lighttng or Heating purposes, by the perfect decomposition of superheated steam, under what is known as the

GWYNNE AND HARRIS PATENTS.

This process has been fully tested nearly 50,000,000 cubic feet of Gas having been made under it, and fully demonstrating the fact that it is the greatest mprovement ever made in the manufacture of Gas, either for Lighting or Heating purposes. With half a ton of Anthracite Coal 150,000 cubic feet of Gas per day is made from three benches, and the labor is so small that one man can attend three or four benches.

The process can be put into either Coal or Oil Gas Works (or where both Coal and Oil are used) at small cost, without any interruption to the working of other benches. The Citizens Gas-Light Company of Brooklyn, after using it for more than seven months, have found it not only far better, but actually *cheaper* than atmospheric air in making Gas, with the use of "petroleum and its products."

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NUMBERS 1 AND 2.

From best London Manufacturers.

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355-

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MANUFACTURED SOLELY BY THE

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ALSO MANUFACTURERS OF

Lap-welded Steam and Gas Pipe,
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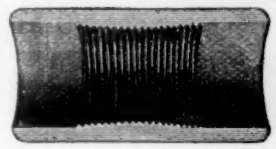

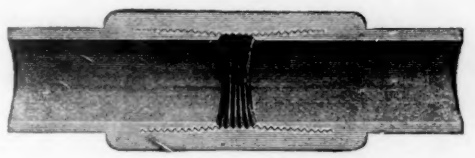

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Offer for Sale the

YOUGHIOGHENY COAL

DOUBLE SCREENED,

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MINES situated on the **Pennsylvania** and the **Connellsville Railroads** in **Westmoreland County, Pa.**

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Since the commencement of operations by this Company its well known

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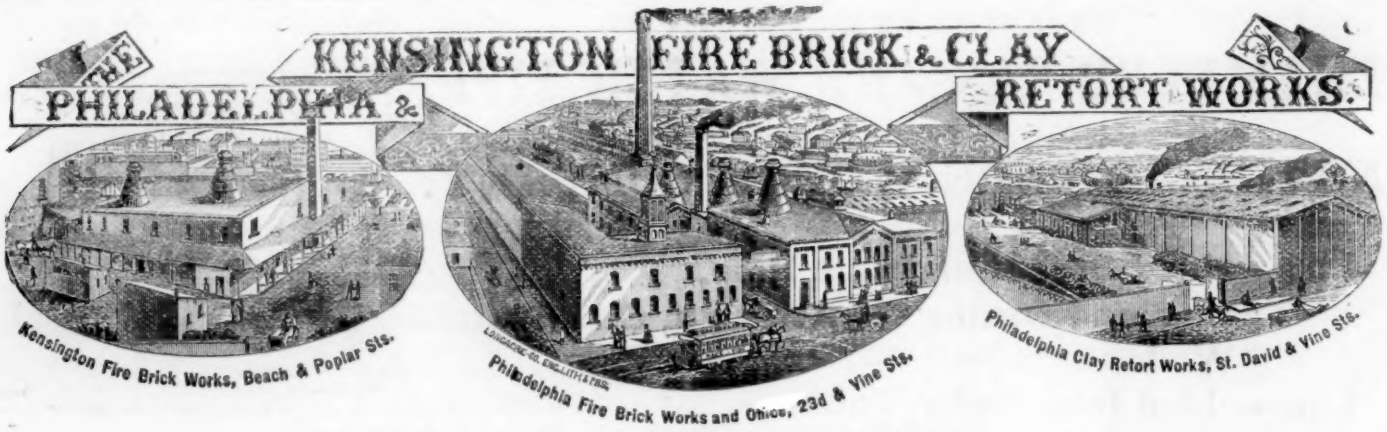
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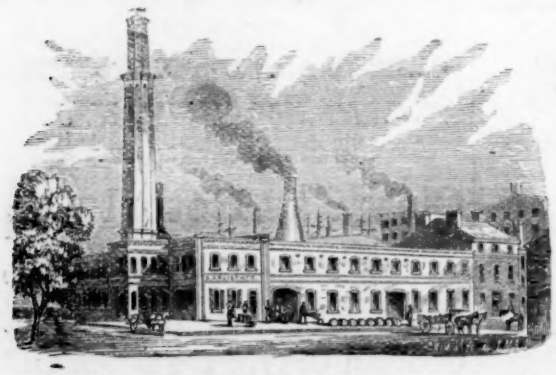

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Retort Works.

☞ *Established in* 1845. ☜
(Branch works at Kreischerville, Staten Island.
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GAS RETORTS, TILES & FIRE BRICK
Of all shapes and sizes.
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Cast Iron Gas and Water Pipe.

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Having withdrawn from the firm of R. D. Wood & Co., the practical management of which we have had since the organization of that firm until June 1871, we have now completed our Works for the manufacture of CAST IRON PIPE and Castings generally.

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Our experience in the manufacture of Pipe for a great many years, has enabled us in rebuilding to practically apply Machinery and Fixtures of the very best character, to insure *good work*.

We are now prepared to contract for this class of Castings under the most favorable terms.

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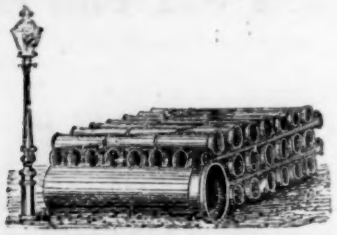

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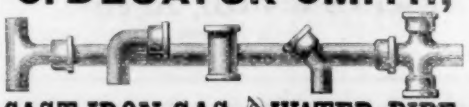

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Several Thousand 2, 3, 4, 6 and 8 Inch Cast Iron *Gas and Water Pipes* on hand, for immediate delivery.

☞ FITTINGS FOR GAS AND WATER MAINS. ☜

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THE GAS-LIGHT CO. OF AMERICA

Nos. 63 and 64 Drexel Building,

P. O. Box, 5131. NEW YORK.

THE GAS-LIGHT COMPANY OF AMERICA, owners of the Patent Processes for making ILLUMINATING GAS from PETROLEUM and its products, known as the

Gale and Rand
AND
Wren and Barker Patents,

are prepared to treat with Gas Companies and Manufacturers of Gas for the use of said processes.

An examination of the merits of these inventions as demonstrated by practical experience in a large number of Gas Works employing them, will not fail to convince the intelligent Gas Manufacturer of the great advantages derived from their use.

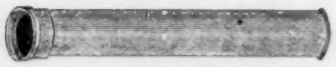
Gas of unexceptional quality, of high illuminating power is made at many of these works by these processes, at a cost of from 40 per cent. to 60 per cent. less than an ordinary qualito of illuminating gas can be made by any other methods in use. Gas Companies generally may easily, and at small outlay for making the necessary changes in manufacturing apparatus, double their net earnings, and supply a much better light their patrons, at greatly reduced prices.

The Company respectfully refer to Companies using these process es in this city, Reading, Penn., Chicago and elsewhere, and especially to the Mutual Gas-Light Company of Detroit, Mich., whose works more nearly conform in all details of construction to the original plans of the inventors than those of other Companies.

For Correspondence, etc., address to office as above.

CHARLES F. DEAN, Secretary

JAMES MARSHALL & CO.
Franklin Foundry and Pipe Works,
MANUFACTURERS OF
GAS, WATER, AND OIL PIPES,



Works, 18th, 19th, 20th and Railroad Street.
Office, No. 23 Nineteenth Street.
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B.—Pipe from 3 inch and upwards cast in 12 ft. lengths.
☞ Send for Circular and Price List.

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FIRE BRICK & ENAMELLED CLAY
RETORT WORKS.

ADAM WEBER,
(Successor to Maurer & Weber.)
Proprietor.
Office and Works, 15th Street, Avenue C.
Manufactures of
FIRE BRICK AND TILES,
Of all shapes and sizes.
FIRE MORTAR, CLAY AND SAND.
☞ Articles of every description made to order at short notice. (135

CHAS. H. MEYER & CO.,

227 Chestnut Street, Philadelphia, Pa.,
IMPORTERS OF
LAVA TIPS AND SCOTCH TIPS.

ALL ORDERS DELIVERED FREE TO NEW YORK.
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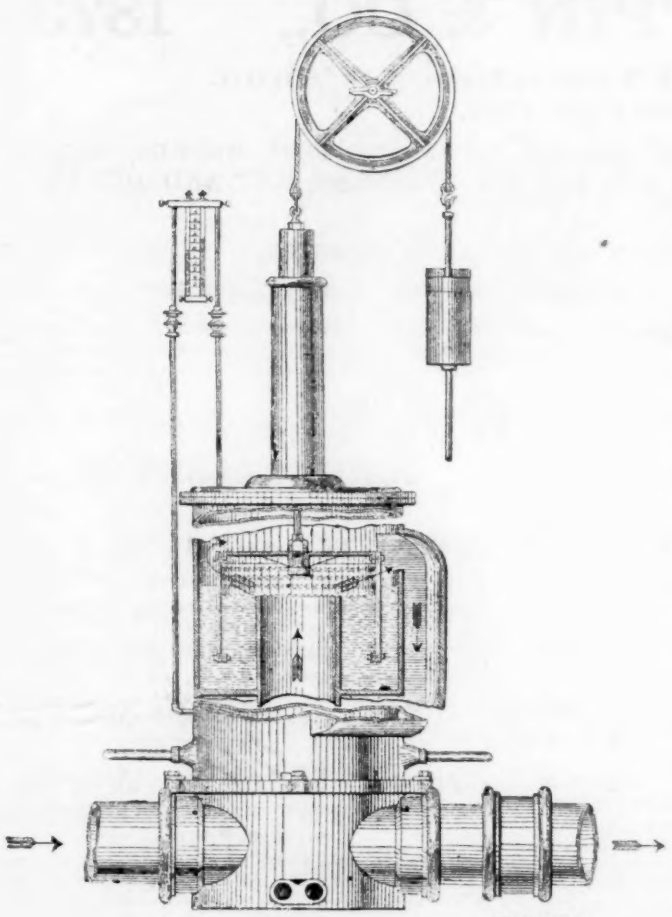

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OR

Sole Agency for the United States.

THE

Pelouze & Audouin Condenser.

PATENT MAY 26, 1874.

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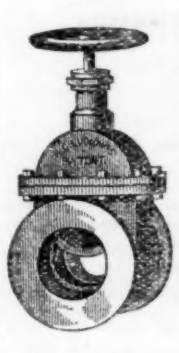

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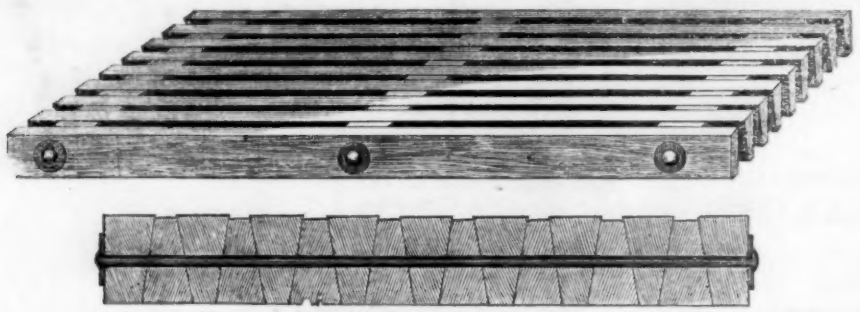

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